

BIOS and Kernel Developer's Guide (BKDG) for AMD Family 16h Models 30h-3Fh Processors

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Revision History

ML BKDG Revision 3.00 Changes, Apr 29, 2014, PUB release

1 Overview

This document defines AMD Family 16h Models 30h-3Fh Processors, henceforth referred to as the processor.

- The processor overview is located at [2.1 \[Processor Overview\]](#).
- The processor is distinguished by the combined ExtFamily and BaseFamily fields of the CPUID instruction (see [CPUID Fn8000_0001_EAX](#) in [3.18 \[CPUID Instruction Registers\]](#)).

1.1 Intended Audience

This document provides the processor behavioral definition and associated design notes. It is intended for platform designers and for programmers involved in the development of low-level BIOS (basic input/output system) functions, drivers, and operating system kernel modules. It assumes prior experience in personal computer platform design, microprocessor programming, and legacy x86 and AMD64 microprocessor architecture. The reader should also have familiarity with various platform technologies, such as DDR DRAM.

1.2 Reference Documents

- Advanced Configuration and Power Interface (ACPI) Specification. www.acpi.info.
- AMD64 Architecture Programmer's Manual Volume 1: Application Programming, #24592.
- AMD64 Architecture Programmer's Manual Volume 2: System Programming, #24593.
- AMD64 Architecture Programmer's Manual Volume 3: Instruction-Set Reference, #24594.
- AMD64 Architecture Programmer's Manual Volume 4: 128-Bit and 256-Bit Media Instructions, #26568.
- AMD64 Architecture Programmer's Manual Volume 5: 64-Bit Media and x87 Floating-Point Instructions, #26569.
- AMD I/O Virtualization Technology (IOMMU) Specification, #34434.
- Software Optimization Guide for AMD Family 16h Processors, #52128.
- Revision Guide for AMD Family 16h Models 30h-3Fh Processors, #53072.
- JEDEC standards. www.jedec.org.
- PCI local bus specification. (www.pcisig.org).
- PCI Express® specification. (www.pcisig.org).
- Universal Serial Bus Specification (<http://www.usb.org>)
- Serial ATA Specification (<http://www.sata-io.org>)
- AT Attachment with Packet Interface (<http://www.t13.org>)
- SD Host Controller Standard Specification (<https://www.sdcard.org>)
- Alert Standard Format Specification (<http://dmtf.org/standards/asf>)

1.3 Conventions

1.3.1 Numbering

- **Binary numbers.** Binary numbers are indicated by appending a “b” at the end, e.g., 0110b.
- **Decimal numbers.** Unless specified otherwise, all numbers are decimal. This rule does not apply to the register mnemonics described in [3.1 \[Register Descriptions and Mnemonics\]](#); register mnemonics all utilize hexadecimal numbering.
- **Hexadecimal numbers.** hexadecimal numbers are indicated by appending an “h” to the end, e.g., 45f8h.
- **Underscores in numbers.** Underscores are used to break up numbers to make them more readable. They do not imply any operation. E.g., 0110_1100b.

1.3.2 Arithmetic And Logical Operators

In this document, formulas generally follow Verilog conventions for logic equations.

Table 1: Arithmetic and Logical Operators

Operator	Definition
{}	Concatenation. Curly brackets are used to indicate a group of bits that are concatenated together. Each set of bits is separated by a comma. E.g., {Addr[3:2], Xlate[3:0]} represents a 6-bit value; the two MSBs are Addr[3:2] and the four LSB's are Xlate[3:0].
	Bitwise OR. E.g. (01b 10b == 11b).
	Logical OR. E.g. (01b 10b == 1b); treats multibit operand as 1 if >=1 and produces a 1-bit result.
&	Bitwise AND. E.g. (01b & 10b == 00b).
&&	Logical AND. E.g. (01b && 10b == 1b); logical treats multibit operand as 1 if >=1 and produces a 1-bit result.
^	Bitwise exclusive-OR. E.g. (01b ^ 10b == 11b). Sometimes used as “raised to the power of” as well, as indicated by the context in which it is used. E.g. (2^2 == 4).
~	Bitwise NOT. (also known as one's complement). E.g. (~10b == 01b).
!	Logical NOT. E.g. (!10b == 0b); treats multibit operand as 1 if >=1 and produces a 1-bit result.
<, <=, >, >=, ==, !=	Relational. Less than, Less than or equal, greater, greater than or equal, equal, and not equal.
+, -, *, /, %	Arithmetic. Addition, subtraction, multiplication, division, and modulus.
<<	Bitwise left shift. Shift left first operand by the number of bits specified by the 2nd operand. E.g. (01b << 01b == 10b).
>>	Bitwise right shift. Shift right first operand by the number of bits specified by the 2nd operand. E.g. (10b >> 01b == 01b).
?:	Ternary conditional. E.g. <i>condition ? value if true : value if false</i> . Equivalent to IF <i>condition</i> THEN <i>value if true</i> ELSE <i>value if false</i> .

Table 2: Functions

Function	Definition
ABS	ABS(integer-expression): Remove sign from signed value.
FLOOR	FLOOR(integer-expression): Rounds real number down to nearest integer.
CEIL	CEIL(real-expression): Rounds real number up to nearest integer.
MIN	MIN(integer-expression-list): Picks minimum integer or real value of comma separated list.
MAX	MAX(integer-expression-list): Picks maximum integer or real value of comma separated list.
COUNT	COUNT(integer-expression): Returns the number of binary 1's in the integer.

Table 2: Functions

Function	Definition
ROUND	ROUND(real-expression): Rounds to the nearest integer; halfway rounds away from zero.
UNIT	UNIT(fieldName UnitOfMeasure): Input operand is a register field name that defines all values with the same unit of measure. Returns the value expressed in the unit of measure for the current value of the register field.
POW	POW(base, exponent): POW(x,y) returns the value x to the power of y.

1.3.3 Operator Precedence and Associativity

This document follows C operator precedence and associativity. The following table lists operator precedence (highest to lowest). Their associativity indicates in what order operators of equal precedence in an expression are applied. Parentheses are also used to group sub-expressions to force a different precedence; such parenthetical expressions can be nested and are evaluated from inner to outer. E.g. “X = A | ~B & C” is the same as “X = A | ((~B) & C)”.

Table 3: Operator Precedence and Associativity

Operator	Description	Associativity
!, ~	Logical negation/bitwise complement	right-to-left
*, /, %	Multiplication/division/modulus	left-to-right
+, -	Addition/subtraction	left-to-right
<<, >>	Bitwise shift left, Bitwise shift right	left-to-right
<, <=, >, >=, ==, !=	Relational operators	left-to-right
&	Bitwise AND	left-to-right
^	Bitwise exclusive OR	left-to-right
	Bitwise inclusive OR	left-to-right
&&	Logical AND	left-to-right
	Logical OR	left-to-right
?:	Ternary conditional	right-to-left

1.4 Definitions

Table 4: Definitions

Term	Definition
AP	Application processor. See 2.3 [Processor Initialization] .
BAPM	Bidirectional Application Power Management. See 2.5.9.3 [Bidirectional Application Power Management (BAPM)] .
Battery-Power	The system is running from a battery power source or otherwise undocked from a continuous power supply. Setting using this definition may be required to change during runtime.
BCS	Base configuration space. See 2.7 [Configuration Space] .

Table 4: Definitions

Term	Definition
BERT	Bit error rate tester. A piece of test equipment that generates arbitrary test patterns and checks that a device under test returns them without errors.
BIST	Built-in self-test. Hardware within the processor that generates test patterns and verifies that they are stored correctly (in the case of memories) or received without error (in the case of links).
Boot VID	Boot voltage ID. This is the VDD and VDDNB voltage level that the processor requests from the external voltage regulator during the initial phase of the cold boot sequence. See 2.5.1.2 [Internal VID Registers and Encodings] .
BCD	Binary coded decimal number format.
BSC	Boot strap core. Core 0 of the BSP . Specified by MSR0000_001B[BSC] .
BSP	Boot strap processor. See 2.3 [Processor Initialization] .
CAR	Use of the L2 cache as RAM during boot. See 2.3.3 [Using L2 Cache as General Storage During Boot] .
C-states	These are ACPI-defined core power states. C0 is operational. All other C-states are low-power states in which the processor is not executing code. See 2.5.3.2 [Core C-states] .
Canonical address	An address in which the state of the most-significant implemented bit is duplicated in all the remaining higher-order bits, up to bit 63.
Channel	See DRAM channel.
CMP	Chip multi-processing. Refers to processors that include multiple cores. See 2.1 [Processor Overview] .
COF	Current operating frequency of a given clock domain. See 2.5.3 [CPU Power Management] .
Cold reset	PWROK is deasserted and RESET_L is asserted. See 2.3 [Processor Initialization] .
Core Cluster	Four Cores that share L2 resources. See L2 complex .
L2 complex	Four Cores that share L2 resources. See 2.1 [Processor Overview] .
Core	The instruction execution unit of the processor. See 2.1 [Processor Overview] .
CPB	Core performance boost. See 2.5.9.1 [Core Performance Boost (CPB)] .
CpuCore-Num	Specifies the core number. See 2.4.4 [Processor Cores and Downcoring] .
CPUID function X	Refers to the CPUID instruction when EAX is preloaded with X. See 3.18 [CPUID Instruction Registers] .
CS	Chip select. See D18F2x[5C:40]_dct[0] [DRAM CS Base Address] .
DCT	DRAM controller. See 2.9 [DRAM Controllers (DCTs)] .
DCQ	DRAM controller queue.
DDR3	DDR3 memory technology. See 2.9 [DRAM Controllers (DCTs)] .
DID	Divisor identifier. Specifies the post-PLL divisor used to reduce the COF. See 2.5.3 [CPU Power Management] .
Doubleword	A 32-bit value.
Downcoring	Removal of cores. See 2.4.4 [Processor Cores and Downcoring] .
DRAM channel	The part of the DRAM interface that connects to a DIMM. See 2.9 [DRAM Controllers (DCTs)] .

Table 4: Definitions

Term	Definition
Dual-Plane	Refers to a processor or systemboard where VDD and VDDNB are separate and may operate at independent voltage levels. Refer to 2.5.1 [Processor Power Planes And Voltage Control] .
DW	Doubleword. A 32-bit value.
ECS	Extended configuration space. See 2.7 [Configuration Space] .
EDS	Electrical data sheet. See 1.2 [Reference Documents] .
FCH	Fusion Controller Hub. The integrated platform device that contains the IO subsystem and the bridge to system BIOS. See 2.17 [Fusion Controller Hub] .
FDS	Functional data sheet; there is one FDS for each package type.
FID	Frequency identifier. Specifies the PLL frequency multiplier for a given clock domain. See 2.5.3 [CPU Power Management] .
FreeR-unSample-Timer	An internal free running timer used by many power management features. The timer increments at the rate specified by D18F4x110[CSampleTimer] .
GB	Gbyte or Gigabyte; 1,073,741,824 bytes.
#GP	A general-protection exception.
#GP(0)	Notation indicating a general-protection exception (#GP) with error code of 0.
GpuEnabled	GpuEnabled = (D1F0x00 !=FFFF_FFFFh).
GT/s	Giga-transfers per second.
HCD	Host Controller Driver. A software component.
HTC	Hardware thermal control. See 2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)] .
HTC-active state	Hardware-controlled lower-power, lower-performance state used to reduce temperature. See 2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)] .
IBS	Instruction based sampling. See 2.6.2 [Instruction Based Sampling (IBS)] .
IFCM	Isochronous flow-control mode, as defined in the link specification.
ILM	Internal loopback mode. Mode in which the link receive lanes are connected directly to the transmit lanes of the same link for testing and characterization. See D18F0x[18C:170] [Link Extended Control] .
IO configuration	Access to configuration space through IO ports CF8h and CFCh. See 2.7 [Configuration Space] .
IORR	IO range register. See MSRC001_00[18,16] [IO Range Base (IORR_BASE[1:0])] .
IOMMU	I/O Memory Management Unit. Also known as AMD Virtualization™ Technology.
KB	Kbyte or Kilobyte; 1024 bytes.
L1 cache	The level 1 caches (instruction cache and the data cache) and the level 2 caches. See 2.1 [Processor Overview] .
L2 cache	
L2I	The L2 Interface complex common to a set of cores.
L2BC	L2I Base Core. The lowest numbered core for a L2I instance.
Linear (virtual) address	The address generated by a core after the segment is applied.
Link	Generic term that refers to a refer to PCIe® link.

Table 4: Definitions

Term	Definition
LINT	Local interrupt.
Logical address	The address generated by a core before the segment is applied.
LVT	Local vector table. A collection of APIC registers that define interrupts for local events. E.g., APIC[530:500] [Extended Interrupt [3:0] Local Vector Table] .
Master abort	This is a PCI-defined term that is applied to transactions on other than PCI buses. It indicates that the transaction is terminated without affecting the intended target; reads return all 1's; writes are discarded; the master abort error code is returned in the response, if applicable; master abort error bits are set if applicable.
MB	Megabyte; 1024 KB.
MCT	Memory controller. See 2.8 [Northbridge (NB)] .
MCQ	Memory controller queue. See 2.8 [Northbridge (NB)] .
Micro-op	Micro-op. Instructions have variable-length encoding and many perform multiple primitive operations. The processor does not execute these complex instructions directly, but, instead, decodes them internally into simpler fixed-length instructions called macro-ops. Processor schedulers subsequently break down macro-ops into sequences of even simpler instructions called micro-ops, each of which specifies a single primitive operation. See <i>Software Optimization Guide for AMD Family 16h Processors</i> .
MEMCLK	Refers to the clock signals, M[B, A][3:0]_CLK, that are driven from the processor to DDR DIMMs.
MMIO	Memory-mapped input-output range. This is physical address space that is mapped to the IO functions such as the IO links or MMIO configuration. The IO link MMIO ranges are specified by D18F1x[2CC:2A0,1CC:180,BC:80] [MMIO Base/Limit] .
MMIO configuration	Access to configuration space through memory space. See 2.7 [Configuration Space] .
MSR	Model-specific register. The core includes several MSRs for general configuration and control. See 3.19 [MSRs - MSR0000_xxxx] for the beginning of the MSR register definitions.
MTRR	Memory-type range register. The MTRRs specify the type of memory associated with various memory ranges. See MSR0000_00FE , MSR0000_020[F:0] , MSR0000_02[6F:68,59:58,50] , and MSR0000_02FF .
NB	Northbridge. The transaction routing block of the node. See 2.1 [Processor Overview] .
NBC	NBC = (CPUID Fn0000_0001_EBX [LocalApicId[3:0]]==0). Node Base Core. The lowest numbered core in the node.
NBPMC	Performance monitor counter. See 2.6.1.3 [NB Performance Monitor Counters] .
NCLK	The main northbridge clock. The NCLK frequency is the NB COF.
Node	See 2.1 [Processor Overview] .
Normalized address	Addresses used by DCTs. See 2.8 [Northbridge (NB)] .
OW	Octword. An 128-bit value.
ODM	On-DIMM mirroring. See D18F2x[5C:40]_dct[0][OnDimmMirror] .
ODT	On-die termination, which is applied DRAM interface signals.
ODTS	DRAM On-die thermal sensor.

Table 4: Definitions

Term	Definition
Operational frequency	The frequency at which the processor operates. See 2.5 [Power Management] .
PCIe®	PCI Express®.
PDS	Product data sheet.
Physical address	Addresses used by cores in transactions sent to the NB.
PMC	Performance monitor counter. See 2.6.1.1 [Core Performance Monitor Counters] .
PRBS	Pseudo-random bit sequence.
Processor	See 2.1 [Processor Overview] .
PSI	Power Status Indicator. See 2.5.1.3.1 [PSIx_L Bit] .
P-state	Performance state. See 2.5 [Power Management] .
PTE	Page table entry.
QW	Quadword. A 64-bit value.
RAS	Reliability, availability and serviceability (industry term). See 2.16.1 [Machine Check Architecture] .
RDQ	Read data queue.
REFCLK	Reference Clock, refers to the clock frequency (100 MHz) or the clock period (10 ns) depending on the context used.
RX	Receiver.
RevA0	RevA0 = ((D18F3xFC[BaseModel] == 0h) && (D18F3xFC[Stepping] == 0h))
RevA1	RevA1 = ((D18F3xFC[BaseModel] == 0h) && (D18F3xFC[Stepping] == 1h)).
Scrubber	Background memory checking logic. See 2.8.3 [Memory Scrubbers] .
Shutdown	A state in which the affected core waits for either INIT, RESET, or NMI. When shutdown state is entered, a shutdown special cycle is sent on the IO links.
Single-Plane	Refers to a processor or systemboard where VDD and VDDNB are tied together and operate at the same voltage level. Refer to 2.5.1 [Processor Power Planes And Voltage Control] .
Slam	Refers to changing the voltage to a new value in one step (as opposed to stepping). See 2.5.1.4.1 [Hardware-Initiated Voltage Transitions] .
SMAF	System management action field. This is the code passed from the SMC to the processors in STPCLK assertion messages. The action taken by the processors in response to this message is specified by D18F3x[84:80] [ACPI Power State Control] .
SMBus	System management bus. Refers to the protocol on which the serial VID interface (SVI) commands are based. See 2.5.1 [Processor Power Planes And Voltage Control] , and 1.2 [Reference Documents] .
SMC	System management controller. This is the platform device that communicates system management state information to the processor through an IO link, typically the system IO hub.
SMI	System management interrupt. See 2.4.8.2.1 [SMM Overview] .
SMM	System management mode. See 2.4.8.2 [System Management Mode (SMM)] .
Speculative event	A performance monitor event counter that counts all occurrences of the event even if the event occurs during speculative code execution.
SVI2	Serial VID 2.0 interface. See 2.5.1.1 [Serial VID Interface]

Table 4: Definitions

Term	Definition
SVM	Secure virtual machine. See 2.4.9 [Secure Virtual Machine Mode (SVM)] .
Sync flood	The propagation of continuous sync packets to all links. This is used to quickly stop the transmission of potentially bad data when there are no other means to do so. See the link specification for additional information.
TCC	Temperature calculation circuit. See 2.10 [Thermal Functions] .
Tctl	Processor temperature control value. See 2.10.3 [Temperature-Driven Logic] .
TDC	Thermal design current. See the AMD Infrastructure Roadmap, #41482.
TDP	Thermal design power. A power consumption parameter that is used in conjunction with thermal specifications to design appropriate cooling solutions for the processor. See 2.5.9.2 [TDP Limiting] .
Token	A scheduler entry used in various northbridge queues to track outstanding requests. See D18F3x140 [SRI to XCS Token Count] on Page 461.
TX	Transmitter.
UI	Unit interval. This is the amount of time equal to one half of a clock cycle.
UMI	Unified Media Interface. The link between the processor and the FCH.
VDD	Main power supply to the processor core logic.
VDDNB	Main power supply to the processor NB logic.
VID	Voltage level identifier. See 2.5.1 [Processor Power Planes And Voltage Control] .
Virtual CAS	The clock in which CAS is asserted for the burst, N, plus the burst length (in MEMCLKs), minus 1; so the last clock of virtual CAS = $N + (BL/2) - 1$.
VRM	Voltage regulator module.
W	Word. A 16-bit value.
Warm reset	RESET_L is asserted only (while PWROK stays high). See 2.3 [Processor Initialization] .
WDT	Watchdog timer. A timer that detects activity and triggers an error if a specified period of time expires without the activity. For example, see MSRC001_0074 [CPU Watchdog Timer (Cpu-WdtCfg)] or the NB watchdog timer in D18F3x40 [MCA NB Control] .
WDQ	Write data queue.
XBAR	Cross bar; command packet switch. See 2.8 [Northbridge (NB)] .

1.5 Changes Between Revisions and Product Variations

1.5.1 Revision Conventions

The processor revision is specified by [CPUID Fn0000_0001_EAX \[Family, Model, Stepping Identifiers\]](#) or [CPUID Fn8000_0001_EAX \[Family, Model, Stepping Identifiers\]](#). This document uses a revision letter instead of specific model numbers. The following table contains the definitions based on model and stepping used in this document. Where applicable, the processor stepping is indicated after the revision letter. All behavior marked with a revision letter apply to future revisions unless they are superseded by a change in a later revision. See the revision guide for additional information about revision determination. See [1.2 \[Reference Documents\]](#).

Table 5: Processor revision conventions

Term	Definition
PROC	PROC = {CPUID Fn0000_0001_EAX[ExtFamily], CPUID Fn0000_0001_EAX[ExtModel], CPUID Fn0000_0001_EAX[BaseModel], CPUID Fn0000_0001_EAX[Stepping]}.
ML_A1	ML_A1 = {07h,3h,0h,1h}.

1.5.2 Major Changes

This section describes the major changes relative to Family 16h Models 00h-0Fh (KB) Processors.

- CPU core changes:
 - Architectural changes:
 - CPUID Fn8000_0001_ECX[PerfTsc]: Support performance time-stamp counter.
 - CPUID Fn8000_0007_EDX[ApmPwrReporting]: Support for processor Power Accumulator.
 - Instruction set changes:
 - CPUID Fn0000_0001_ECX[RDRAND]: Added RDRAND instruction support.
- Graphics Northbridge:
 - Platform Security Processor (PSP).

1.5.2.1 Major Changes to Core/NB Performance Counters

Major Changes to Core/NB Performance Counters:

2 Functional Description

2.1 Processor Overview

The *processor* is defined as follows:

- The processor is a package that contains one node.
- Supports x86-based instruction sets.
- Packages:
 - FT3b (BGA).
 - FP4: (BGA).
 - See CPUID Fn8000_0001_EBX[PkgType].
- L2 complex

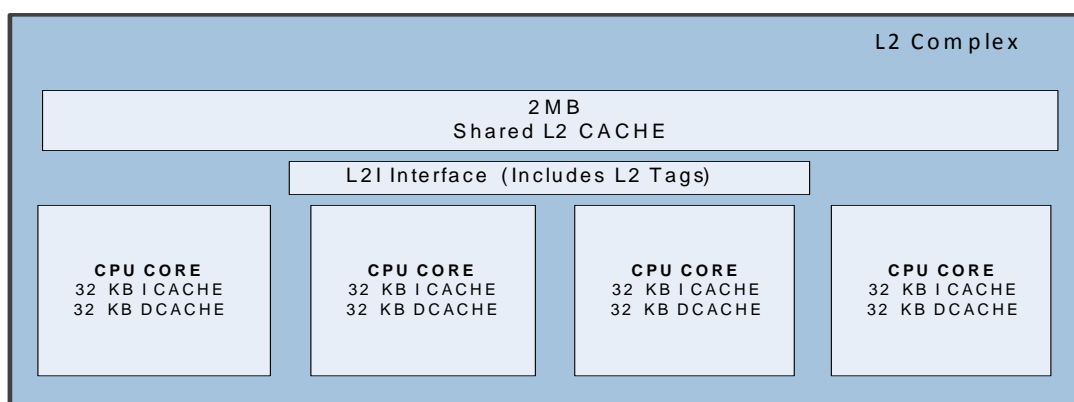


Figure 1: A L2 Complex

- 1 L2 complex (4 cores)
- 2 MB L2
- See [2.4.1 \[L2 complex\]](#).
- DRAM:
 - One 64-bit DDR3 memory channel (A).
- Northbridge:
 - One communication packet routing block referred to as the northbridge (NB). The NB routes transactions between the cores, the link, and the DRAM interfaces. It includes the configuration register space for the device.
- Graphics northbridge:
 - Link:
 - PCIe Gen2
 - One x4 Gfx link, four x1 GPP links.
 - See [2.11.3 \[Links\]](#).
- Power Management:
 - See [2.5 \[Power Management\]](#).
- RAS:
 - See [2.16 \[RAS Features\]](#).

2.2 System Overview

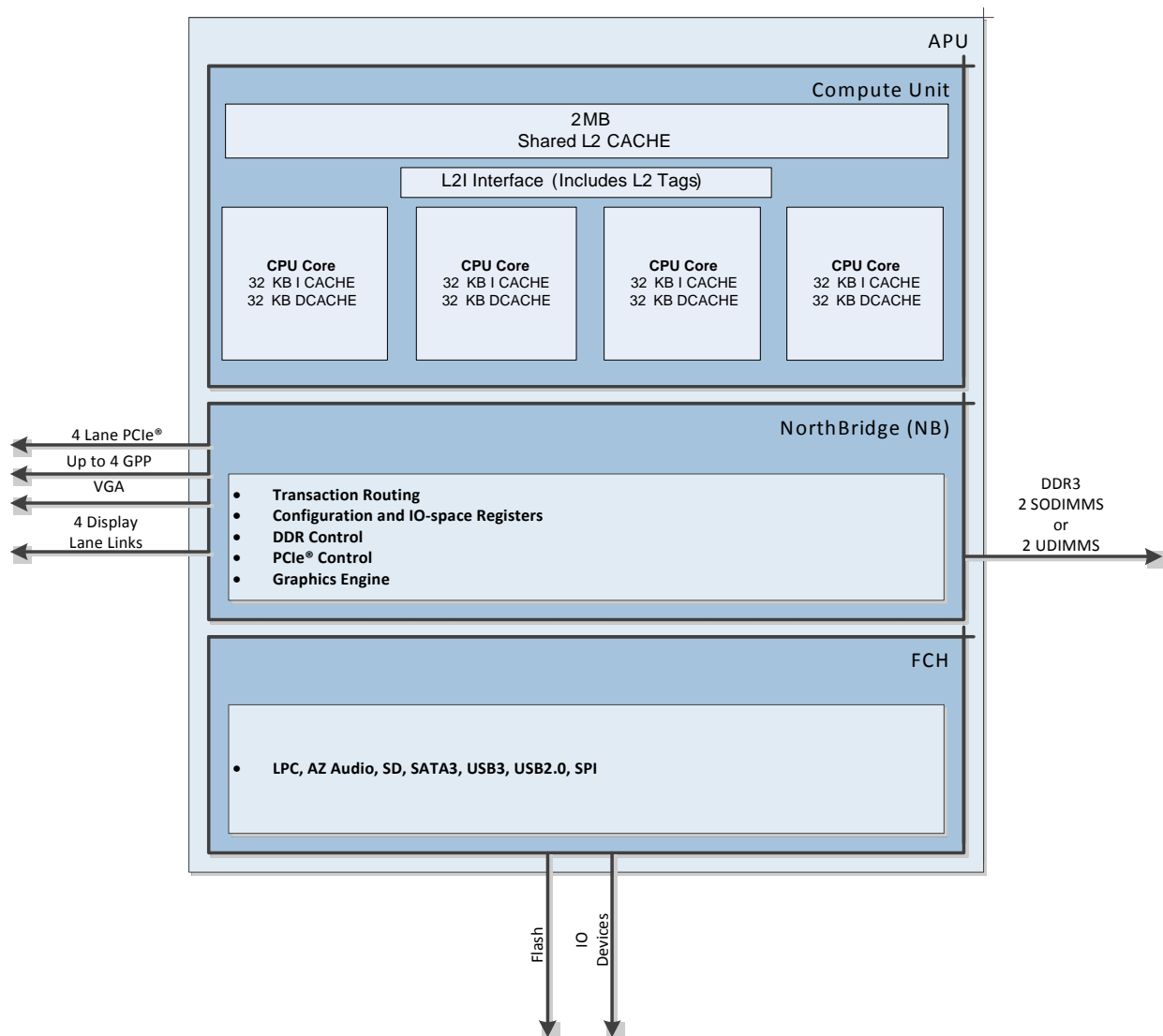


Figure 2: System Diagram

2.3 Processor Initialization

This section describes the initialization sequence after a cold reset.

Core 0 of the processor, the bootstrap core (BSC), begins executing code from the reset vector. The remaining cores do not fetch code until their enable bits are set (**D18F0x1DC[CpuEn]**).

2.3.1 BSC Initialization

The BSC must perform the following tasks as part of boot.

- Store BIST information from the EAX register into an unused processor register.

- [D18F0x6C](#)[InitDet] may be used by BIOS to differentiate between INIT and cold/warm reset.
- Determine type of startup using [D18F0x6C](#)[ColdRstDet].
 - If this is a warm reset then BIOS may check for valid MCA errors and if present save the status for later use. See [2.16.1.6 \[Handling Machine Check Exceptions\]](#).
- Enable the cache, program the MTRRs for [CAR](#) and initialize [CAR](#). See [2.3.3 \[Using L2 Cache as General Storage During Boot\]](#).
- Setup the SMU.
- Setup of APIC ([2.4.8.1.3 \[ApicId Enumeration Requirements\]](#)).
- Setup the link configuration [2.11.3.2 \[Link Configurations\]](#).
- Setup the root complex and initialize the I/O links [2.11.4.3 \[Link Configuration and Initialization\]](#).
- If required, reallocate data and flow control buffers of the links (see [D18F0x\[F0,D0,B0,90\] \[Link Base Channel Buffer Count\]](#) and [D18F0x\[F4,D4,B4,94\] \[Link Isochronous Channel Buffer Count\]](#)).
- Issue system warm reset.
- Configure the DRAM controllers.
- Configure processor power management. See [2.5 \[Power Management\]](#).
- Allow other cores to begin fetching instructions by setting [D18F0x1DC](#)[CpuEn] in the PCI configuration space of all nodes. See [2.4.4 \[Processor Cores and Downcoring\]](#).

2.3.2 AP Initialization

All other processor cores other than core 0 begin executing code from the reset vector. They must perform the following tasks as part of boot.

- Store BIST information from the `eax` register into an unused processor register.
- [D18F0x6C](#)[InitDet] may be used by BIOS to differentiate between INIT and cold/warm reset.
- Determine the history of this reset using the [D18F0x6C \[Link Initialization Control\] \[ColdRstDet\]](#) bit:
 - If this is a warm reset then BIOS may check for valid MCA errors and if present save the status for use later. See [2.16.1.6 \[Handling Machine Check Exceptions\]](#).
- Set up the local APIC. See [2.4.8.1.3 \[ApicId Enumeration Requirements\]](#).
- Configure processor power management. See [2.4 \[Core\]](#).

2.3.3 Using L2 Cache as General Storage During Boot

Prior to initializing the DRAM controller for system memory, BIOS may use the L2 cache as general storage. If BIOS is not using L2 cache as general storage during boot, program [MSRC001_102A](#)[CILinesToL2Dis]=0.

The L2 cache as general storage is described as follows:

- Each L2 complex has its own L2 cache.
- BIOS manages the mapping of the L2 storage such that cacheable accesses do not cause L2 victims.
- The L2 size, L2 associativity, and L2 line size is determined by reading [CPUID Fn8000_0006_ECX](#)[L2Size, L2Assoc, L2LineSize]. L2WayNum is defined to be the number of ways indicated by the L2Assoc code.
 - The L2 cache is viewed as (L2Size/L2LineSize) cache lines of storage, organized as L2WayNum ways, each way being (L2Size/L2WayNum) in size.
 - E.g. L2Assoc=8 so L2WayNum=16 (there are 16 ways). If (L2Size=2MB) then there are 16 blocks of cache, each 2MB/16 in size, or 128KB each.
 - For each of the following values of L2Size, the following values are defined:
 - L2Size=1 MB: L2Tag=PhysAddr[39:16], L2WayIndex=PhysAddr[15:6].
 - L2Size=2 MB: L2Tag=PhysAddr[39:17], L2WayIndex=PhysAddr[16:6].
 - PhysAddr[5:0] addresses the L2LineSize number of bytes of storage associated with the cache line.
 - The L2 cache, when allocating a line at L2WayIndex:

- Picks an invalid way before picking a valid way.
- Prioritizes the picking of invalid ways such that way 0 is the highest priority and L2WayNum-1 is the lowest priority.
- It is recommended that BIOS assume a simpler allocation of L2 cache memory, being L2WayNum size-aligned blocks of memory, each being L2Size/L2WayNum bytes.
- BIOS can rely on a minimum L2Size of 1 MB and can rely on being able to use all 16 ways for general storage. See [CPUID Fn8000_0006_ECX\[L2Size\]](#).

The following memory types are supported:

- **WP-IO:** BIOS ROM may be assigned the write-protect IO memory type and may be accessed read-only as data and fetched as instructions.
 - WP-IO accesses, both read and write, do not get allocated into the L2 and therefore do not need to be considered for allocation into the L2.
- **WB-DRAM:** General storage may be assigned the write-back DRAM memory type and may be accessed as read-write data, but not accessed by instruction fetch.
 - BIOS initializes an L2LineSize sized and aligned location in the L2 cache, mapped as write-back DRAM, with 1 read to at least 1 byte of the L2LineSize sized and aligned WB-DRAM address. BIOS may store to a line only after it has been allocated by a load.
 - Fills, sent to the disabled memory controller, return undefined data.
- All of memory space that is not accessed as WP-IO or WB-DRAM space must be marked as UC memory type.
- In order to prevent victimizing L2 data, no more than L2WayNum cache lines accessed as WB-DRAM may have the same L2WayIndex.
 - Software does not need to know which ways the L2WayNum lines are allocated to for any given value of L2WayIndex, only that invalid ways will be selected for allocation before valid ways will be selected for allocation.
 - Software is not allowed to deallocate a line in the L2 by using CLFLUSH.

Performance monitor event [L2IPMCx060\[3:2\]](#), titled “write victim block“, can be used to indicate whether L2 dirty data was lost by being victimized and sent to the disabled memory controller.

The following requirements must be satisfied prior to using the cache as general storage:

- Paging must be disabled.
- [MSRC001_0015\[INVDWBINVD\]](#)=0.
- [MSRC001_1021\[DisSpecTlbRld\]](#)=1. Disable speculative ITLB reloads.
- [MSRC001_1022\[DisSpecTlbWalk\]](#)=1. Disable speculative DTLB reloads.
- [MSRC001_1022\[DisHwPf\]](#)=1.
- [MSRC001_10A0\[L2RinserDis\]](#)=1.
- [MSRC001_10A0\[PrefetcherDis\]](#)=1. Disable L2 hardware prefetcher.
- [MSRC001_10A0\[CacheIcAttrDis\]](#)=1.
- CLFLUSH, INVD, and WBINVD must not be used during [CAR](#) but may be used when tearing down [CAR](#) for all compute units on a node.
- The BIOS must not use SSE, or MMX™ instructions, with the exception of the following list: MOVD, MOVQ, MOVDQA, MOVQ2DQ, MOVDQ2Q.
- The BIOS must not enable exceptions, page-faults, and other interrupts.
- BIOS must not use software prefetches.
- **UC-DRAM:** All of DRAM that is not accessed as WB-DRAM space must be marked as UC memory type.

When BIOS has completed using the cache for general storage the following steps are followed:

1. Prior to issuing an INVD instruction, BIOS must ensure that no other source of coherent traffic, such as a DMA engine, is operating in the system. This condition must hold true until the INVD instruction for tear-down has been executed on all CPUs.
2. An INVD instruction is executed on each core that used cache as general storage; an INVD is issued when all cores on all nodes have completed using the cache for general storage.
3. If DRAM is initialized and there is data in the cache that needs to get moved to main memory, CLFLUSH or WBINVD may be used instead of INVD, but software must ensure that needed data in main memory is not overwritten.
4. Program the following configuration state (Order is unimportant):
 - [MSRC001_0015](#)[INVDWBINVD]=1.
 - [MSRC001_1021](#)[DisSpecTlbRld]=0.
 - [MSRC001_1022](#)[DisSpecTlbWalk]=0.
 - [MSRC001_1022](#)[DisHwPf]=0.
 - [MSRC001_10A0](#)[PrefetcherDis]=0.
 - [MSRC001_10A0](#)[CacheIcAttrDis]=0.
 - [MSRC001_102A](#)[CtLinesToL2Dis]=0.

2.3.4 Instruction Cache Configuration Register Usage Requirements

Modification of [MSRC001_1021](#) [Instruction Cache Configuration (IC_CFG)] requires the following steps for all cores within the L2 complex:

- Synchronize all cores.
- Modify [MSRC001_1021](#) observing the [Same-for-all](#) requirement.
- Flush all caches using WBINVD for all cores within the L2 complex.
- Resume all cores.

2.4 Core

The majority of the behavioral definition of the core is specified in the AMD64 Architecture Programmer's Manual. See [1.2](#) [Reference Documents].

2.4.1 L2 complex

Each *L2 complex* includes 4 cores each having an x86 instruction execution logic and first-level (L1) data cache and first-level (L1) instruction cache. The second level (L2) general-purpose cache is shared between all cores of the L2 complex.

There is a set of MSRs and APIC registers associated with each core. Processors that include multiple cores are said to incorporate *chip multi-processing* or CMP. Unless otherwise specified the processor configuration interface hides the L2 complex implementation and presents software with homogenous cores, each independent of the other.

Software may use [D18F5x80](#)[Enabled, DualCore, TripleCore, QuadCore] in order to associate a core with a L2 complex. This information can be useful because some configuration settings are determined based on active L2 complexes and core performance may vary based on resource sharing within a L2 complex.

Table 6: Compute Unit Definitions

Term	Definition
NumOfL2Complexes	The number of L2 complexes for which at least 1 core is enabled. NumOfL2Complexes = COUNT(D18F5x80 [Enabled]).

2.4.2 Caches and TLBs

Cache and TLB storage available to a core is reported by:

- [CPUID Fn8000_0005_EAX](#)-[CPUID Fn8000_0006_EDX](#).
- [CPUID Fn8000_0019_EAX](#)-[CPUID Fn8000_0019_E\[D,C\]X](#).
- [CPUID Fn8000_001D_EAX_x0](#)-[CPUID Fn8000_001E_EDX](#).

Cache and TLB storage available to a core is summarized as follows:

- L1 and L2 Caches:
 - DC: 32 KB, 8-way, write-back, per-core.
 - IC: 32 KB, 2-way, per-core.
 - L2: 1 MB or 2 MB (Product-specific), 16-way associative, shared between all cores of a L2 complex.
- TLBs:
 - D, L1TLB:
 - 4 KB: 40 entries, fully associative.
 - 2 MB: 8 entries, fully associative.
 - D, L2TLB:
 - 4 KB: 512 entries, 4 way associative
 - 2 MB: 256 entries, hashed 2 way associative.
 - I, L1TLB:
 - 4 KB: 32 entries, fully associative.
 - 2 MB, 8 entries, fully associative.
 - I, L2TLB:
 - 4 KB: 512 entries, 4-way associative.

2.4.2.1 Registers Shared by Cores in a L2 complex

Some registers are implemented one instance per L2 complex instead of per core; these registers are designated as [Per-L2](#). The absence of [Per-L2](#) implies the normal per-core instance programming model.

Programming rules for [Per-L2](#) registers:

- Software must ensure that a shared MSR written by one core on a L2 complex will not cause a problem for software that is running on the other core of the L2 complex.
- [Per-L2](#): A write to a [Per-L2](#) MSR does not have to be written to the other cores of the L2 complex in order for the other cores to see the updated value.
- A read-modify-write of a shared MSR register is not atomic. Software must ensure atomicity between the cores that could simultaneously read-modify-write the shared register.

2.4.3 Virtual Address Space

The processor supports 48 address bits of virtual memory space (256 TB) as indicated by [CPUID Fn8000_0008_EAX](#).

2.4.4 Processor Cores and Downcoring

Each L2 Complex supports downcoring as follows:

- The number of cores supported is specified by [D18F5x84\[CmpCap\]](#).
- The cores of a L2 complex may be software downcored by [D18F3x190\[DisCore\]](#). See 2.4.4.1 [Software Downcoring using [D18F3x190\[DisCore\]](#)].
 - Clocks are turned off and power is gated to downcored L2 complexes. The power savings is the same as CC6.
 - There must be at least 1 L2 complex enabled.

- **D18F3x190**[DisCore] affects the value of **CPUID Fn0000_0001_EBX**[LogicalProcessorCount], **CPUID Fn0000_0001_EDX**[HTT], **CPUID Fn8000_0001_ECX**[CmpLegacy], **CPUID Fn8000_0008_ECX**[NC], **D18F5x80**[Enabled, DualCore, TripleCore, QuadCore]. **D18F3x190**[DisCore] does not affect the value of **D18F5x84**[CmpCap].
- An implemented (physical) core that is downcored is not visible to software. Cores that are not downcored are numbered logically in a contiguous manner.
- **D18F5x80** [Compute Unit Status 1] reports core topology information to software.
- The number of cores specified in **CPUID Fn8000_0008_ECX**[NC] must be the same as the number of cores enabled in **D18F0x1DC**[CpuEn].
- The core number, *CpuCoreNum*, is provided to SW running on each core through **CPUID Fn0000_0001_EBX**[LocalApicId] and **APIC20**[ApicId]; *CpuCoreNum* also affects **D18F0x1DC**[CpuEn]. *CpuCoreNum*, varies as the lowest integers from 0 to **D18F5x84**[CmpCap], based on the number of enabled cores; e.g., a 4-core node with 1 core disabled results in cores reporting *CpuCoreNum* values of 0, 1, and 2 regardless of which core is disabled. The boot core is always the core reporting *CpuCoreNum*=0.

Some legacy operating systems do not support processors with a non-power-of-2 number of cores. The BIOS is recommended to support a user configurable option to disable cores down to a power-of-2 number of cores for legacy operating system support.

2.4.4.1 Software Downcoring using **D18F3x190**[DisCore]

Cores may be downcored by **D18F3x190**[DisCore].

Software is required to use **D18F3x190**[DisCore] as follows:

- Setting bits corresponding to cores that are not present results in undefined behavior.
- Once a core has been removed by **D18F3x190**[DisCore]=1, it cannot be added back without a cold reset. E.g. Software may only set DisCore bits, never clear them.
- Once a core has been removed by **D18F3x190**[DisCore]=1, software must issue warm reset without an intervening halt.
- The most significant bit N is (the number of cores)-1 at cold reset; the number of cores at cold reset is (**CPUID Fn8000_0008_ECX**[NC]+1).
- The most significant bit N and the core ID significance of DisCore is not affected by the value of DisCore followed by a warm-reset.
 - E.g. If core 2 is disabled by DisCore[3:0]=0100b followed by a warm reset, then the new core 2 is the old core 3. If the new core 2 needs to then be disabled then DisCore[3:0]=1100b followed by a warm reset.
- All bits greater than bit N are reserved.
- If **D18F3x190**[DisCore] is changed, then the following need to be updated:
 - **D18F0x60**[CpuCnt[4:0]].
 - **D18F5x170**[NbPstateThreshold]

2.4.5 Physical Address Space

The processor supports a 40 bit physical address space, as indicated by **CPUID Fn8000_0008_EAX** [Long Mode Address Size Identifiers].

The processor master aborts the following upper-address transactions (to address PhysAddr):

- Link or core requests with non-zero PhysAddr[63:40].

2.4.6 System Address Map

The processor defines a reserved memory address region starting at 0000_00FD_0000_0000h and extending up to 0000_0100_0000_0000h. System software must not map memory into this region. Downstream host accesses to the reserved address region results in a page fault. Upstream system device accesses to the reserved address region results in an undefined operation.

2.4.6.1 Memory Access to the Physical Address Space

All memory accesses to the physical address space from a core are sent to its associated northbridge (NB). All memory accesses from a link are routed through the NB. An IO link access to physical address space indicates to the NB the cache attribute (Coherent or Non-coherent, based on bit[0] of the Sized Read and Write commands).

A core access to physical address space has two important attributes that must be determined before issuing the access to the NB: the memory type (e.g., WB, WC, UC; as described in the MTRRs) and the access destination (DRAM or MMIO).

This mechanism is managed by the BIOS and does not require any setup or changes by system software.

2.4.6.1.1 Determining Memory Type

The memory type for a core access is determined by the highest priority of the following ranges that the access falls in: 1==Lowest priority.

1. The memory type as determined by architectural mechanisms.
 - See the APM2 chapter titled “Memory System”, sections “Memory-Type Range Registers” and “Page-Attribute Table Mechanism”.
 - See the APM2 chapter titled “Nested Paging”, section “Combining Memory Types, MTRRs”.
 - See [MSR0000_02FF \[MTRR Default Memory Type \(MTRRdefType\)\]](#), [MSR0000_020\[F:0\] \[Variable-Size MTRRs Base/Mask\]](#), [MSR0000_02\[6F:68,59:58,50\] \[Fixed-Size MTRRs\]](#).
2. TSeg & ASeg SMM mechanism. (see [MSRC001_0112](#) and [MSRC001_0113](#))
3. CR0[CD]: If (CR0[CD]==1) then MemType=CD.
4. MMIO config space, APIC space.
 - MMIO APIC space and MMIO config space must not overlap.
 - MemType=UC.
 - See [2.4.8.1.2 \[APIC Register Space\]](#) and [2.7 \[Configuration Space\]](#).
5. If (“In SMM Mode” && ~(([MSRC001_0113](#)[AValid] && “The address falls within the ASeg region”) || ([MSRC001_0113](#)[TValid] && “The address falls within the TSeg region”))) then MemType=CD.

2.4.6.1.2 Determining The Access Destination for Core Accesses

The access destination, DRAM or MMIO, is based on the highest priority of the following ranges that the access falls in: 1==Lowest priority.

1. RdDram/WrDram as determined by [MSRC001_001A \[Top Of Memory \(TOP_MEM\)\]](#) and [MSRC001_001D \[Top Of Memory 2 \(TOM2\)\]](#).
2. The IORRs. (see [MSRC001_00\[18,16\]](#) and [MSRC001_00\[19,17\]](#)).
3. The fixed MTRRs. (see [MSR0000_02\[6F:68,59:58,50\] \[Fixed-Size MTRRs\]](#))
4. TSeg & ASeg SMM mechanism. (see [MSRC001_0112](#) and [MSRC001_0113](#))
5. MMIO config space, APIC space.
 - MMIO APIC space and MMIO config space must not overlap.
 - RdDram=IO, WrDram=IO.
 - See [2.4.8.1.2 \[APIC Register Space\]](#) and [2.7 \[Configuration Space\]](#).

6. NB address space routing. See [2.8.2.1.1 \[DRAM and MMIO Memory Space\]](#).

2.4.7 Timers

Each core includes the following timers. These timers do not vary in frequency regardless of the current P-state or C-state.

- [MSR0000_0010 \[Time Stamp Counter \(TSC\)\]](#); the TSC increments at the rate specified by the P0 P-state.
 - See [2.5.3.1.1.1 \[Software P-state Numbering\]](#).
 - See [MSRC001_00\[6B:64\] \[P-state \[7:0\]\]](#).
- The APIC timer ([APIC380](#) and [APIC390](#)), which increments at the rate of 2xCLKIN; the APIC timer may increment in units of between 1 and 8.

2.4.8 Interrupts

2.4.8.1 Local APIC

The local APIC contains logic to receive interrupts from a variety of sources and to send interrupts to other local APICs, as well as registers to control its behavior and report status. Interrupts can be received from:

- IO devices including the IO hub (IO APICs)
- Other local APICs (inter-processor interrupts)
- APIC timer
- Thermal events
- Performance counters
- Legacy local interrupts from the IO hub (INTR and NMI)
- APIC internal errors

The APIC timer, thermal events, performance counters, local interrupts, and internal errors are all considered local interrupt sources, and their routing is controlled by local vector table entries. These entries assign a message type and vector to each interrupt, allow them to be masked, and track the status of the interrupt.

IO and inter-processor interrupts have their message type and vector assigned at the source and are unaltered by the local APIC. They carry a destination field and a mode bit that together determine which local APIC(s) accepts them. The destination mode (DM) bit specifies if the interrupt request packet should be handled in physical or logical destination mode. If the destination field matches the broadcast value specified by [D18F0x68\[ApicExtBrdCst\]](#), then the interrupt is a broadcast interrupt and is accepted by all local APICs regardless of destination mode.

2.4.8.1.1 Detecting and Enabling

APIC is detected and enabled via [CPUID Fn0000_0001_EDX\[APIC\]](#).

The local APIC is enabled via [MSR0000_001B\[ApicEn\]](#). Reset forces APIC disabled.

2.4.8.1.2 APIC Register Space

MMIO APIC space:

- Memory mapped to a 4 KB range. The memory type of this space is the UC memory type. The base address of this range is specified by {[MSR0000_001B\[ApicBar\[47:12\]\]](#), 000h}.
- The mnemonic is defined to be APICXX; XX is the byte address offset from the base address.
- MMIO APIC registers in xAPIC mode is defined by the register from [APIC20](#) to [APIC\[530:500\]](#).

- Treated as normal memory space when APIC is disabled, as specified by [MSR0000_001B](#)[ApicEn].

2.4.8.1.3 ApicId Enumeration Requirements

System hardware and BIOS must ensure that the number of cores per processor (NC) exposed to the operating system by all tables, registers, and instructions across all cores in the processor is identical. See [2.4.10.1 \[Multi-Core Support\]](#) to derive NC.

Operating systems are expected to use [CPUID Fn8000_0008_ECX](#)[ApicIdCoreIdSize], the number of least significant bits in the Initial APIC ID that indicate core ID within a processor, in constructing per-core CPUID masks. (ApicIdCoreIdSize[3:0] determines the maximum number of cores (MNC) that the processor could theoretically support, not the actual number of cores that are actually implemented or enabled on the processor, as indicated by [CPUID Fn8000_0008_ECX](#)[NC].) $MNC = (2^{\text{ApicIdCoreIdSize}})$. BIOS must use the ApicId MNC rule when assigning [APIC20](#)[ApicId] values as described below.

ApicId MNC rule: The ApicId of core j on processor i must be enumerated/assigned as:

- $\text{ApicId}[\text{proc}=i, \text{core}=j] = (\text{OFFSET_IDX} + i) * \text{MNC} + j$
- Where OFFSET_IDX is an integer offset (0 to N) used to shift up the core ApicId values to allow room for IOAPIC devices.

It is recommended that BIOS use the following APIC ID assignments for the broadest operating system support. Given $N = (\text{Number_Of_Processors} * \text{MNC})$ and $M = \text{Number_Of_IOAPICs}$:

- If $(N+M) < 16$, then assign the local (core) ApicIds first from 0 to N-1, and the IOAPIC IDs from N to $N+(M-1)$. APIC ID 15 is reserved for broadcast when [APIC410](#)[ExtApicIdEn]==0.
- If $(N+M) \geq 16$, then assign the IOAPIC IDs first from 0 to M-1, and the local (core) ApicIds from K to $K+(N-1)$, where K is an integer multiple of MNC greater than M-1.

2.4.8.1.4 Physical Destination Mode

The interrupt is only accepted by the local APIC whose [APIC20](#)[ApicId] matches the destination field of the interrupt. Physical mode allows up to 255 APICs to be addressed individually.

2.4.8.1.5 Logical Destination Mode

A local APIC accepts interrupts selected by [APICD0](#) [Logical Destination (LDR)] and the destination field of the interrupt using either cluster or flat format as configured by [APICE0](#)[Format].

If flat destinations are in use, bits 7-0 of [APICD0](#)[Destination] are checked against bits 7-0 of the arriving interrupt's destination field. If any bit position is set in both fields, the local APIC is a valid destination. Flat format allows up to 8 APICs to be addressed individually.

If cluster destinations are in use, bits 7-4 of [APICD0](#)[Destination] are checked against bits 7-4 of the arriving interrupt's destination field to identify the cluster. If all of bits 7-4 match, then bits 3-0 of [APICD0](#)[Destination] and the interrupt destination are checked for any bit positions that are set in both fields to identify processors within the cluster. If both conditions are met, the local APIC is a valid destination. Cluster format allows 15 clusters of 4 APICs each to be addressed.

2.4.8.1.6 Interrupt Delivery

SMI, NMI, INIT, Startup, and External interrupts are classified as non-vectored interrupts.

When an APIC accepts a non-vectored interrupt, it is handled directly by the processor instead of being queued

in the APIC. When an APIC accepts a fixed or lowest-priority interrupt, it sets the bit in [APIC\[270:200\] \[Interrupt Request \(IRR\)\]](#) corresponding to the vector in the interrupt. For local interrupt sources, this comes from the vector field in that interrupt's local vector table entry. The corresponding bit in [APIC\[1F0:180\] \[Trigger Mode \(TMR\)\]](#) is set if the interrupt is level-triggered and cleared if edge-triggered. If a subsequent interrupt with the same vector arrives when the corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) is already set, the two interrupts are collapsed into one. Vectors 15-0 are reserved.

2.4.8.1.7 Vectored Interrupt Handling

[APIC80 \[Task Priority \(TPR\)\]](#) and [APICA0 \[Processor Priority \(PPR\)\]](#) each contain an 8-bit priority divided into a main priority (bits 7-4) and a priority sub-class (bits 3-0). The task priority is assigned by software to set a threshold priority at which the processor is interrupted.

The processor priority is calculated by comparing the main priority (bits 7-4) of [APIC80\[Priority\]](#) to bits 7-4 of the 8-bit encoded value of the highest bit set in [APIC\[170:100\] \[In-Service \(ISR\)\]](#). The processor priority is the higher of the two main priorities.

The processor priority is used to determine if any accepted interrupts (indicated by [APIC\[270:200\]\[Request-Bits\]](#)) are high enough priority to be serviced by the processor. When the processor is ready to service an interrupt, the highest bit in [APIC\[270:200\]\[RequestBits\]](#) is cleared, and the corresponding bit is set in [APIC\[170:100\]\[InServiceBits\]](#).

When the processor has completed service for an interrupt, it performs a write to [APICB0 \[End of Interrupt\]](#), clearing the highest bit in [APIC\[170:100\]\[InServiceBits\]](#) and causing the next-highest interrupt to be serviced. If the corresponding bit in [APIC\[1F0:180\]\[TriggerModeBits\]](#) is set, a write to [APICB0](#) is performed on all APICs to complete service of the interrupt at the source.

2.4.8.1.8 Interrupt Masking

Interrupt masking is controlled by the [APIC410 \[Extended APIC Control\]](#). If [APIC410\[IerEn\]](#) is set, [APIC\[4F0:480\] \[Interrupt Enable\]](#) are used to mask interrupts. Any bit in [APIC\[4F0:480\]\[InterruptEnableBits\]](#) that is clear indicates the corresponding interrupt is masked. A masked interrupt is not serviced and the corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) remains set.

2.4.8.1.9 Spurious Interrupts

In the event that the task priority is set to or above the level of the interrupt to be serviced, the local APIC delivers a spurious interrupt vector to the processor, as specified by [APICF0 \[Spurious-Interrupt Vector \(SVR\)\]](#). [APIC\[170:100\]](#) is not changed and no write to [APICB0](#) occurs.

2.4.8.1.10 Spurious Interrupts Caused by Timer Tick Interrupt

A typical interrupt is asserted until it is serviced. An interrupt is deasserted when software clears the interrupt status bit within the interrupt service routine. Timer tick interrupt is an exception, since it is deasserted regardless of whether it is serviced or not.

The processor is not always able to service interrupts immediately (i.e. when interrupts are masked by clearing [EFLAGS.IM](#)).

If the processor is not able to service the timer tick interrupt for an extended period of time, the INTR caused by the first timer tick interrupt asserted during that time is delivered to the local APIC in ExtInt mode and latched, and the subsequent timer tick interrupts are lost. The following cases are possible when the processor

is ready to service interrupts:

- An ExtInt interrupt is pending, and INTR is asserted. This results in timer tick interrupt servicing. This occurs 50 percent of the time.
- An ExtInt interrupt is pending, and INTR is deasserted. The processor sends the interrupt acknowledge cycle, but when the PIC receives it, INTR is deasserted, and the PIC sends a spurious interrupt vector. This occurs 50 percent of the time.

There is a 50 percent probability of spurious interrupts to the processor.

2.4.8.1.11 Lowest-Priority Interrupt Arbitration

Fixed, remote read, and non-vectored interrupts are accepted by their destination APICs without arbitration.

Delivery of lowest-priority interrupts requires all APICs to arbitrate to determine which one accepts the interrupt. If [APICF0\[FocusDisable\]](#) is clear, then the focus processor for an interrupt always accepts the interrupt. A processor is the focus of an interrupt if it is already servicing that interrupt (corresponding bit in [APIC\[170:100\]\[InServiceBits\]](#) is set) or if it already has a pending request for that interrupt (corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) is set). If [APIC410\[IerEn\]](#) is set the interrupt must also be enabled in [APIC\[4F0:480\]\[InterruptEnableBits\]](#) for a processor to be the focus processor. If there is no focus processor for an interrupt, or focus processor checking is disabled, then each APIC calculates an arbitration priority value, stored in [APIC90 \[Arbitration Priority \(APR\)\]](#), and the one with the lowest result accepts the interrupt.

The arbitration priority value is calculated by comparing [APIC80\[Priority\]](#) with the 8-bit encoded value of the highest bit set in [APIC\[270:200\]\[RequestBits\]](#) (IRRVec) and the 8-bit encoded value of the highest bit set in [APIC\[170:100\]\[InServiceBits\]](#) (ISRVec). If [APIC410\[IerEn\]](#) is set the IRRVec and ISRVec are based off the highest enabled interrupt. The main priority bits 7-4 are compared as follows:

```
IF ((APIC80[Priority[7:4]] >= IRRVec[7:4]) && (APIC80[Priority[7:4]] > ISRVec[7:4])) THEN
    APIC90[Priority] = APIC80[Priority]
ELSEIF (IRRVec[7:4] > ISRVec[7:4]) THEN
    APIC90[Priority] = {IRRVec[7:4],0h}
ELSE
    APIC90[Priority] = {ISRVec[7:4],0h}
ENDIF.
```

2.4.8.1.12 Inter-Processor Interrupts

[APIC300 \[Interrupt Command Low \(ICR Low\)\]](#) and [APIC310 \[Interrupt Command High \(ICR High\)\]](#) provide a mechanism for generating interrupts in order to redirect an interrupt to another processor, originate an interrupt to another processor, or allow a processor to interrupt itself. A write to register [APIC300](#) causes an interrupt to be generated with the properties specified by the [APIC300](#) and [APIC310](#) fields.

2.4.8.1.13 APIC Timer Operation

The local APIC contains a 32-bit timer, controlled by [APIC320 \[LVT Timer\]](#), [APIC380 \[Timer Initial Count\]](#), and [APIC3E0 \[Timer Divide Configuration\]](#). The processor bus clock is divided by the value in [APIC3E0\[Div\]](#) to obtain a time base for the timer. When [APIC380\[Count\]](#) is written, the value is copied into [APIC390 \[Timer Current Count\]](#). [APIC390\[Count\]](#) is decremented at the rate of the divided clock. When the count reaches 0, a timer interrupt is generated with the vector specified in [APIC320\[Vector\]](#). If [APIC320\[Mode\]](#) specifies periodic operation, [APIC390\[Count\]](#) is reloaded with the [APIC380\[Count\]](#) value, and it continues to decrement at the rate of the divided clock. If [APIC320\[Mask\]](#) is set, timer interrupts are not generated.

2.4.8.1.14 Generalized Local Vector Table

All LVTs ([APIC330](#) to [APIC3\[60:50\]](#), and [APIC\[530:500\]](#)) support a generalized message type as follows:

- 000b=Fixed
- 010b=SMI
- 100b=NMI
- 111b=ExtINT
- All other messages types are reserved.

2.4.8.1.15 State at Reset

At power-up or reset, the APIC is hardware disabled ([MSR0000_001B](#)[ApicEn]=0) so only SMI, NMI, INIT, and ExtInt interrupts may be accepted.

The APIC can be software disabled through [APICF0](#)[APICSWEn]. The software disable has no effect when the APIC is hardware disabled.

When a processor accepts an INIT interrupt, the APIC is reset as at power-up, with the exception that:

- [APIC20](#)[ApicId] is unaffected.
- Pending APIC register writes complete.

2.4.8.2 System Management Mode (SMM)

System management mode (SMM) is typically used for system control activities such as power management. These activities are typically transparent to the operating system.

2.4.8.2.1 SMM Overview

SMM is entered by a core on the next instruction boundary after a system management interrupt (SMI) is received and recognized. A core may be programmed to broadcast a special cycle to the system, indicating that it is entering SMM mode. The core then saves its state into the SMM memory state save area and jumps to the SMI service routine (or SMI handler). The pointer to the SMI handler is specified by MSRs. The code and data for the SMI handler are stored in the SMM memory area, which may be isolated from the main memory accesses.

The core returns from SMM by executing the RSM instruction from the SMI handler. The core restores its state from the SMM state save area and resumes execution of the instruction following the point where it entered SMM. The core may be programmed to broadcast a special bus cycle to the system, indicating that it is exiting SMM mode.

2.4.8.2.2 Operating Mode and Default Register Values

The software environment after entering SMM has the following characteristics:

- Addressing and operation is in Real mode.
 - A far jump, call or return in the SMI handler can only address the lower 1M of memory, unless the SMI handler first switches to protected mode.
 - If ([MSRC001_0111](#)[SmmBase]>=0010_0000h) then:
 - The value of the CS selector is undefined upon SMM entry.
 - The undefined CS selector value should not be used as the target of a far jump, call, or return.
- 4-Gbyte segment limits.
- Default 16-bit operand, address, and stack sizes (instruction prefixes can override these defaults).
- Control transfers that do not override the default operand size truncate the EIP to 16 bits.

- Far jumps or calls cannot transfer control to a segment with a base address requiring more than 20 bits, as in Real mode segment-base addressing, unless a change is made into protected mode.
- A20M# is disabled. A20M# assertion or deassertion have no affect during SMM.
- Interrupt vectors use the Real mode interrupt vector table.
- The IF flag in EFLAGS is cleared (INTR is not recognized).
- The TF flag in EFLAGS is cleared.
- The NMI and INIT interrupts are masked.
- Debug register DR7 is cleared (debug traps are disabled).

The SMM base address is specified by [MSRC001_0111](#)[SmmBase]. Important offsets to the base address pointer are:

- [MSRC001_0111](#)[SmmBase] + 8000h: SMI handler entry point.
- [MSRC001_0111](#)[SmmBase] + FE00h - FFFFh: SMM state save area.

2.4.8.2.3 SMI Sources And Delivery

The processor accepts SMIs as link-defined interrupt messages only. The core/node destination of these SMIs is a function of the destination field of these messages. However, the expectation is that all such SMI messages are specified to be delivered globally (to all cores of all nodes).

There are also several local events that can trigger SMIs. However, these local events do not generate SMIs directly. Each of them triggers a programmable IO cycle that is expected to target the SMI command port in the IO hub and trigger a global SMI interrupt message back to the coherent fabric.

Local sources of SMI events that generate the IO cycle specified in [MSRC001_0056](#) [SMI Trigger IO Cycle] are:

- In the core, as specified by:
 - [MSRC001_0022](#) [Machine Check Exception Redirection].
 - [MSRC001_00](#)[53:50] [IO Trap (SMI_ON_IO_TRAP_[3:0])].
- All local APIC LVT registers programmed to generate SMIs.

The status for these is stored in [SMMFEC4](#).

2.4.8.2.4 SMM Initial State

After storing the save state, execution starts at [MSRC001_0111](#)[SmmBase] + 08000h. The SMM initial state is specified in the following table.

Table 7: SMM Initial State

Register	SMM Initial State
CS	SmmBase[19:4]
DS	0000h
ES	0000h
FS	0000h
GS	0000h
SS	0000h
General-Purpose Registers	Unmodified
EFLAGS	0000_0002h

Table 7: SMM Initial State

Register	SMM Initial State
RIP	0000_0000_0000_8000h
CR0	Bits 0, 2, 3, and 31 cleared (PE, EM, TS, and PG); remainder is unmodified
CR4	0000_0000_0000_0000h
GDTR	Unmodified
LDTR	Unmodified
IDTR	Unmodified
TR	Unmodified
DR6	Unmodified
DR7	0000_0000_0000_0400h
EFER	All bits are cleared except bit 12 (SVME) which is unmodified.

2.4.8.2.5 SMM Save State

In the following table, the offset field provides the offset from the SMM base address specified by [MSRC001_0111 \[SMM Base Address \(SMM_BASE\)\]](#).

Table 8: SMM Save State

Offset	Size	Contents		Access
FE00h	Word	ES	Selector	Read-only
FE02h	6 Bytes		Reserved	
FE08h	Quadword		Descriptor in memory format	
FE10h	Word	CS	Selector	Read-only
FE12h	6 Bytes		Reserved	
FE18h	Quadword		Descriptor in memory format	
FE20h	Word	SS	Selector	Read-only
FE22h	6 Bytes		Reserved	
FE28h	Quadword		Descriptor in memory format	
FE30h	Word	DS	Selector	Read-only
FE32h	6 Bytes		Reserved	
FE38h	Quadword		Descriptor in memory format	
FE40h	Word	FS	Selector	Read-only
FE42h	2 Bytes		Reserved	
FE44h	Doubleword		FS Base {16'b[47], 47:32} ¹	
FE48h	Quadword		Descriptor in memory format	
FE50h	Word	GS	Selector	Read-only
FE52h	2 Bytes		Reserved	
FE54h	Doubleword		GS Base {16'b[47], 47:32} ¹	
FE58h	Quadword		Descriptor in memory format	

Table 8: SMM Save State

Offset	Size	Contents		Access
FE60h	4 Bytes	GDTR	Reserved	Read-only
FE64h	Word		Limit	
FE66h	2 Bytes		Reserved	
FE68h	Quadword		Descriptor in memory format	
FE70h	Word	LDTR	Selector	Read-only
FE72h	Word		Attributes	
FE74h	Doubleword		Limit	
FE78h	Quadword		Base	
FE80h	4 Bytes	IDTR	Reserved	Read-only
FE84h	Word		Limit	
FEB6h	2 Bytes		Reserved	
FE88h	Quadword		Base	
FE90h	Word	TR	Selector	Read-only
FE92h	Word		Attributes	
FE94h	Doubleword		Limit	
FE98h	Quadword		Base	
FEA0h	Quadword	IO_RESTART_RIP		Read-only
FEA8h	Quadword	IO_RESTART_RCX		
FEB0h	Quadword	IO_RESTART_RSI		
FEB8h	Quadword	IO_RESTART_RDI		
FEC0h	Doubleword	SMMFEC0 [SMM IO Trap Offset]		Read-only
FEC4	Doubleword	SMMFEC4 [Local SMI Status]		Read-only
FEC8h	Byte	SMMFEC8 [SMM IO Restart Byte]		Read-write
FEC9h	Byte	SMMFEC9 [Auto Halt Restart Offset]		Read-write
FECAh	Byte	SMMFECA [NMI Mask]		Read-write
FECBh	5 Bytes	Reserved		
FED0h	Quadword	EFER		Read-only
FED8h	Quadword	SMMFED8 [SMM SVM State]		Read-only
FEE0h	Quadword	Guest VMCB physical address		Read-only
FEE8h	Quadword	SVM Virtual Interrupt Control		Read-only
FEF0h	16 Bytes	Reserved		
FEFCh	Doubleword	SMMFEFC [SMM-Revision Identifier]		Read-only
FF00h	Doubleword	SMMFF00 [SMM Base Address (SMM_BASE)]		Read-write
FF04h	28 Bytes	Reserved		

Table 8: SMM Save State

Offset	Size	Contents	Access
FF20h	Quadword	Guest PAT	Read-only
FF28h	Quadword	Host EFER ²	
FF30h	Quadword	Host CR4 ²	
FF38h	Quadword	Nested CR3 ²	
FF40h	Quadword	Host Cr0 ²	
FF48h	Quadword	CR4	
FF50h	Quadword	CR3	
FF58h	Quadword	CR0	
FF60h	Quadword	DR7	Read-only
FF68h	Quadword	DR6	
FF70h	Quadword	RFLAGS	Read-write
FF78h	Quadword	RIP	Read-write
FF80h	Quadword	R15	
FF88h	Quadword	R14	
FF90h	Quadword	R13	
FF98h	Quadword	R12	
FFA0h	Quadword	R11	
FFA8h	Quadword	R10	
FFB0h	Quadword	R9	
FFB8h	Quadword	R8	
FFC0h	Quadword	RDI	Read-write
FFC8h	Quadword	RSI	
FFD0h	Quadword	RBP	
FFD8h	Quadword	RSP	
FFE0h	Quadword	RBX	
FFE8h	Quadword	RDX	
FFF0h	Quadword	RCX	
FFF8h	Quadword	RAX	

Notes:

1. This notation specifies that bit[47] is replicated in each of the 16 MSBs of the DW (sometimes called *sign extended*). The 16 LSB's contain bits[47:32].
2. Only used for an SMI in guest mode with nested paging enabled.

The SMI save state includes most of the integer execution unit. Not included in the save state are: the floating point state, MSRs, and CR2. In order to be used by the SMI handler, these must be saved and restored. The save state is the same, regardless of the operating mode (32-bit or 64-bit).

The following are some offsets in the SMM save state area. The mnemonic for each offset is in the form SMMxxxx, where xxxx is the offset in the save state.

SMMFEC0 SMM IO Trap Offset

If the assertion of SMI is recognized on the boundary of an IO instruction, [SMMFEC0 \[SMM IO Trap Offset\]](#) contains information about that IO instruction. For example, if an IO access targets an unavailable device, the system can assert SMI and trap the IO instruction. [SMMFEC0](#) then provides the SMI handler with information about the IO instruction that caused the trap. After the SMI handler takes the appropriate action, it can reconstruct and then re-execute the IO instruction from SMM. Or, more likely, it can use [SMMFEC8 \[SMM IO Restart Byte\]](#), to cause the core to re-execute the IO instruction immediately after resuming from SMM.

Bits	Description
31:16	Port: trapped IO port address. Read-only. This provides the address of the IO instruction.
15:12	BPR: IO breakpoint match. Read-only.
11	TF: EFLAGS TF value. Read-only.
10:7	Reserved.
6	SZ32: size 32 bits. Read-only. 1=Port access was 32 bits.
5	SZ16: size 16 bits. Read-only. 1= Port access was 16 bits.
4	SZ8: size 8 bits. Read-only. 1=Port access was 8 bits.
3	REP: repeated port access. Read-only.
2	STR: string-based port access. Read-only.
1	V: IO trap word valid. Read-only. 1=The core entered SMM on an IO instruction boundary; all information in this offset is valid. 0=The other fields of this offset are not valid.
0	RW: port access type. Read-only. 0=IO write (OUT instruction). 1=IO read (IN instruction).

SMMFEC4 Local SMI Status

This offset stores status bits associated with SMI sources local to the core. For each of these bits, 1=The associated mechanism generated an SMI.

Bits	Description
31:18	Reserved.
17	SmiSrcLvtExt: SMI source LVT extended entry. Read-only. This bit is associated with the SMI sources specified in APIC[530:500] [Extended Interrupt [3:0] Local Vector Table] .
16	SmiSrcLvtLcy: SMI source LVT legacy entry. Read-only. This bit is associated with the SMI sources specified by the non-extended LVT entries of the APIC.
15:9	Reserved.
8	MceRedirSts: machine check exception redirection status. Read-only. This bit is associated with the SMI source specified in MSRC001_0022[RedirSmiEn] .
7:4	Reserved.
3:0	IoTrapSts: IO trap status. Read-only. Each of these bits is associated with each of the respective SMI sources specified in MSRC001_00[53:50] [IO Trap (SMI_ON_IO_TRAP_[3:0])] .

SMMFEC8 SMM IO Restart Byte

00h on entry into SMM.

If the core entered SMM on an IO instruction boundary, the SMI handler may write this to FFh. This causes the core to re-execute the trapped IO instruction immediately after resuming from SMM. The SMI handler should only write to this byte if **SMMFEC0** field V==1; otherwise, the behavior is undefined.

If a second SMI is asserted while a valid IO instruction is trapped by the first SMI handler, the core services the second SMI prior to re-executing the trapped IO instruction. **SMMFEC0** field V==0 during the second entry into SMM, and the second SMI handler must not rewrite this byte.

If there is a simultaneous SMI IO instruction trap and debug breakpoint trap, the processor first responds to the SMI and postpones recognizing the debug exception until after resuming from SMM. If debug registers other than DR6 and DR7 are used while in SMM, they must be saved and restored by the SMI handler. If **SMMFEC8 [SMM IO Restart Byte]**, is set to FFh when the RSM instruction is executed, the debug trap does not occur until after the IO instruction is re-executed.

Bits	Description
7:0	RST: SMM IO Restart Byte. Read-write.

SMMFEC9 Auto Halt Restart Offset

Bits	Description
7:1	Reserved.
0	HLT: halt restart. Read-write. Upon SMM entry, this bit indicates whether SMM was entered from the Halt state. 0=Entered SMM on a normal x86 instruction boundary. 1=Entered SMM from the Halt state. Before returning from SMM, this bit can be written by the SMI handler to specify whether the return from SMM should take the processor back to the Halt state or to the instruction-execution state specified by the SMM state save area (normally, the instruction after the halt). 0=Return to the instruction specified in the SMM save state. 1=Return to the halt state. If the return from SMM takes the processor back to the Halt state, the HLT instruction is not refetched and re-executed. However, the Halt special bus cycle is broadcast and the processor enters the Halt state.

SMMFECA NMI Mask

Bits	Description
7:1	Reserved.
0	NmiMask. Read-write. Specifies whether NMI was masked upon entry to SMM. 0=NMI not masked. 1=NMI masked.

SMMFED8 SMM SVM State

Read-only. This offset stores the SVM state of the processor upon entry into SMM.

Bits	Description
63:4	Reserved.

3	HostEflagsIf: host Eflags IF.														
2:0	SvmState. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>SMM entered from a non-guest state.</td></tr> <tr> <td>001b</td><td>Reserved.</td></tr> <tr> <td>010b</td><td>SMM entered from a guest state.</td></tr> <tr> <td>101b-011b</td><td>Reserved.</td></tr> <tr> <td>110b</td><td>SMM entered from a guest state with nested paging enabled.</td></tr> <tr> <td>111b</td><td>Reserved.</td></tr> </table>	Bits	Definition	000b	SMM entered from a non-guest state.	001b	Reserved.	010b	SMM entered from a guest state.	101b-011b	Reserved.	110b	SMM entered from a guest state with nested paging enabled.	111b	Reserved.
Bits	Definition														
000b	SMM entered from a non-guest state.														
001b	Reserved.														
010b	SMM entered from a guest state.														
101b-011b	Reserved.														
110b	SMM entered from a guest state with nested paging enabled.														
111b	Reserved.														

SMMFEFC SMM-Revision Identifier

SMM entry state: 0003_0064h

Bits	Description
31:18	Reserved.
17	BRL. Read-only. Base relocation supported.
16	IOTrap. Read-only. IO trap supported.
15:0	Revision. Read-only.

SMMFF00 SMM Base Address (SMM_BASE)

Bits	Description
31:0	See: MSRC001_0111 [SmmBase].

2.4.8.2.6 Exceptions and Interrupts in SMM

When SMM is entered, the core masks INTR, NMI, SMI, INIT, and A20M interrupts. The core clears the IF flag to disable INTR interrupts. To enable INTR interrupts within SMM, the SMM handler must set the IF flag to 1. A20M is disabled so that address bit 20 is never masked when in SMM.

Generating an INTR interrupt can be used for unmasking NMI interrupts in SMM. The core recognizes the assertion of NMI within SMM immediately after the completion of an IRET instruction. Once NMI is recognized within SMM, NMI recognition remains enabled until SMM is exited, at which point NMI masking is restored to the state it was in before entering SMM.

While in SMM, the core responds to the DBREQ and STPCLK interrupts, as well as to all exceptions that may be caused by the SMI handler.

2.4.8.2.7 The Protected ASeg and TSeg Areas

These ranges are controlled by [MSRC001_0112](#) and [MSRC001_0113](#); see those registers for details.

2.4.8.2.8 SMM Special Cycles

Special cycles can be initiated on entry and exit from SMM to acknowledge to the system that these transitions are occurring. These are controlled by [MSRC001_0015](#)[RsmSpCycDis, SmiSpCycDis].

2.4.8.2.9 Locking SMM

The SMM registers ([MSRC001_0112](#) and [MSRC001_0113](#)) can be locked from being altered by setting [MSRC001_0015](#)[SmmLock]. SBIOS must lock the SMM registers after initialization to prevent unexpected changes to these registers.

2.4.8.2.10 Synchronizing SMM Entry (Spring-Boarding)

The BIOS must take special care to ensure that all cores have entered SMM prior to accessing shared IO resources and all core SMI interrupt status bits are synchronized. This generally requires that BIOS waits for all cores to enter SMM.

The following conditions can cause one or more cores to enter SMM without all cores entering SMM:

- More than one IO device in the system is enabled to signal an SMI without hardware synchronization (e.g. using an end of SMI gate).
- A single device may signal multiple SMI messages without hardware synchronization (e.g. using an end of SMI gate).
- An SMI is received while one or more AP cores are in the INIT state. This may occur either during BIOS or secure boot.
- A hardware error prevents a core from entering SMM.

The act of synchronizing cores into SMM is called spring-boarding. Because not all of the above conditions can be avoided, it is recommended that all systems support spring-boarding.

An ACPI-compliant IO hub is required for spring-boarding. Depending on the IO hub design, BIOS may have to set additional end-of-SMI bits to trigger an SMI from within SMM.

The software requirements for the suggested spring-boarding implementation are listed as follows.

- A binary semaphore located in SMRAM, accessible by all cores. For the purpose of this discussion, the semaphore is called CheckSpringBoard. CheckSpringBoard is initialized to zero.
- Two semaphores located in SMRAM, accessible by all cores. For the purpose of this discussion, the semaphores are called NotInSMM and WaitInSMM. NotInSMM and WaitInSMM are initialized to a value equal to the number of cores in the system (NumCPUs).

The following BIOS algorithm describes spring-boarding and is optimized to reduce unnecessary SMI activity. This algorithm must be made part of the SMM instruction sequence for each core in the system.

1. Attempt to obtain ownership of the CheckSpringBoard semaphore with a read-modify-write instruction. If ownership was obtained then do the following, else proceed to step 2:

- Check all enabled SMI status bits in the IO hub.
Let Status=enable1&status1 | enable2&status2 | enable3&status3 ... enable n & status n.
- If (Status==0) then perform the following sub-actions.
 - Trigger an SMI broadcast assertion from the IO hub by writing to the software SMI command port.
 - Resume from SMM with the RSM instruction.

//Example:

```
InLineASM{
    BTS CheckSpringBoard,0; Try to obtain ownership of semaphore
    JC Step_2:
    CALL CheckIOHUB_SMIEVT; proc returns ZF=1 for no events
    JNZ Step_2:
    CALL Do_SpringBoard;Trigger SMI and then RSM
```

```

    Step_2:
}

```

2. Decrement the NotInSMM variable. Wait for (NotInSMM==0). See Note 1.
3. Execute the core-local event SMI handler. Using a third semaphore (not described here), synchronize core execution at the end of the task. After all cores have executed, proceed to step 4. The following is a brief description of the task for each core:
 - Check all enabled core-local SMI status bits in the core's private or MSR address space. Handle the event if possible, or pass information necessary to handle the event to a mailbox for the BSC to handle.
 - An exclusive mailbox must exist for each core for each core local event.
 - Wait for all cores to complete this task at least once.
4. If the current core executing instructions is not the BSC then jump to step 5. If the core executing instructions is the BSC then jump to the modified main SMI handler task, described below.
 - Check all enabled SMI status bits in the IO hub. Check mailboxes for event status.
 - For each event, handle the event and clear the corresponding status bit.
 - Repeat until all enabled SMI status bits are clear and no mailbox events remain.
 - Set NotInSMM=NumCPUs. (Jump to step 5.)
5. Decrement the WaitInSMM variable. Wait for WaitInSMM=0. See Note 2.
6. Increment the WaitInSMM variable. Wait for WaitInSMM=NumCPUs.
7. If the current processor core executing instructions is the BSC then reset CheckSpringBoard to zero.
8. Resume from SMM with the RSM instruction.

Notes:

1. To support a secure startup by the secure loader the BIOS must provide a timeout escape from the otherwise endless loop. The timeout value should be large enough to account for the latency of all cores entering SMM. The maximum SMM entrance latency is defined by the platform's IO sub-system, not the processor. A value of twice the watchdog timer count is recommended. See [D18F3x44 \[MCA NB Configuration\]](#) for more information on the watchdog time-out value. If a time-out occurs in the wait loop, the BIOS (the last core to decrement NotInSMM) should record the number of cores that have not entered SMM and all cores must fall out of the loop.
2. If a time-out occurs in the wait loop in step 2, the BIOS must not wait for WaitInSMM=0. Instead it must wait for WaitInSMM=(the number of cores recorded in step 2).
3. If BIOS places APs in the INIT state during any part of the boot process when SMIs may be generated, or may generate SMIs before taking all APs out of their initial microcode reset loop (i.e., before [D18F0x1DC\[CpuEn\]](#) is set), then it is recommended that BIOS keep a record of how many APs are in these two states and exclude these cores from the wait loops. SMIs are not recognized by a processor in these states. AMD does not recommend enabling SMI sources prior to bringing all APs out of these states.

2.4.9 Secure Virtual Machine Mode (SVM)

Support for SVM mode is indicated by [CPUID Fn8000_0001_ECX\[SVM\]](#).

2.4.9.1 BIOS support for SVM Disable

The BIOS should include the following user setup options to enable and disable AMD Virtualization™ technology.

- Enable AMD Virtualization™.
 - [MSRC001_0114\[SvmeDisable\]](#) = 0.
 - [MSRC001_0114\[Lock\]](#) = 1.
 - [MSRC001_0118\[SvmLockKey\]](#) = 0000_0000_0000_0000h.
- Disable AMD Virtualization™.

- [MSRC001_0114](#)[SvmeDisable]=1.
- [MSRC001_0114](#)[Lock]=1.
- [MSRC001_0118](#)[SvmLockKey] = 0000_0000_0000_0000h.

The BIOS may also include the following user setup options to disable AMD Virtualization™ technology.

- Disable AMD Virtualization™, with a user supplied key.
 - [MSRC001_0114](#)[SvmeDisable]=1.
 - [MSRC001_0114](#)[Lock]=1.
 - [MSRC001_0118](#)[SvmLockKey] programmed with value supplied by user. This value should be stored in NVRAM.

2.4.10 CPUID Instruction

The CPUID instruction provides data about the features supported by the processor. See [3.18 \[CPUID Instruction Registers\]](#).

2.4.10.1 Multi-Core Support

There are two methods for determining multi-core support. A recommended mechanism is provided and a legacy method is also available for existing operating systems. System software should use the correct architectural mechanism to detect the number of physical cores by observing [CPUID Fn8000_0008_ECX](#)[NC]. The legacy method utilizes the [CPUID Fn0000_0001_EBX](#)[LogicalProcessorCount].

2.5 Power Management

The processor supports many power management features in a variety of systems. [Table 9](#) provides a summary of ACPI states and power management features and indicates whether they are supported.

Table 9: Power Management Support

ACPI/Power Management State	Supported	Description
G0/S0/C0: Working	Yes	
G0/S0/C0: Core P-state transitions	Yes	2.5.3.1 [Core P-states]
G0/S0/C0: NB P-state transitions	Yes	2.5.4.1 [NB P-states]
G0/S0/C0: Hardware thermal control (HTC)	Yes	2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)]
G0/S0/Per-core IO-based C-states	Yes	2.5.3.2 [Core C-states] and 2.5.1.3.2 [Low Power Voltages]
G0/S0/C1: Halt	Yes	
G0/S0/CC6: Per-core Power gating	Yes	2.5.3.2 [Core C-states]
G0/S0: CPC-L2 power gating	Yes	2.5.3.2 [Core C-states]
G0/S0/PC6: 0V support (VDD power plane).	Yes	2.5.3.2 [Core C-states] and 2.5.1.3.2 [Low Power Voltages]
G0/S0/Cx: Cache flushing support	Yes	2.5.3.2.3.1 [C-state Probes and Cache Flushing]
G0/S0: Northbridge C-states (DRAM self-refresh, NB clock-gating)	Yes	2.5.4.2 [NB C-states]
G1/S1: Stand By (Powered On Suspend)	No	
G1/S3: Stand By (Suspend to RAM)	Yes	2.5.8.1 [S-states]
G1/S4: Hibernate (Suspend to Disk)	Yes	
G1/S5: Shut Down (Soft Off)	Yes	
G3 Mechanical Off	Yes	
Parallel VID Interface	No	2.5.1 [Processor Power Planes And Voltage Control]
Serial VID Interface 1	No	
Serial VID Interface 2	Yes	
Single-plane systems	No	
Number of voltage planes	2	2.5.1 [Processor Power Planes And Voltage Control]
APM: Application Power Management	Yes	2.5.9 [Application Power Management (APM)]

2.5.1 Processor Power Planes And Voltage Control

Refer to the *Electrical Data Sheet* for power plane definitions. See [1.2 \[Reference Documents\]](#).

2.5.1.1 Serial VID Interface

The processor includes an interface to control external voltage regulators, called the serial VID interface (SVI). Only SVI2 is supported. The frequency of SVC for SVI2 is controlled by [D18F3xA0\[Svi2HighFreqSel\]](#). See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

2.5.1.1.1 SVI2 Features

The processor supports the following SVI2 features:

- Voltage offsets:
 - VDD: [D18F5x12C](#)[CoreOffsetTrim].
 - VDDNB: [D18F5x188](#)[NbOffsetTrim].
- Load line trim:
 - VDD: [D18F5x12C](#)[CoreLoadLineTrim].
 - VDDNB: [D18F5x188](#)[NbLoadLineTrim].

2.5.1.2 Internal VID Registers and Encodings

All VID register fields within the processor are 8-bits wide. The VID encodings to voltage translation for all VID codes are defined by the SVI mode. See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

The boot VID is 0.9 volts.

2.5.1.2.1 MinVid and MaxVid Check

Hardware limits the minimum and maximum VID code that is sent to the voltage regulator. The allowed limits are specified in [D18F5x17C](#)[MinVid, MaxVid]. Prior to generating VID-change commands to SVI, the processor filters the InputVid value to the OutputVid as follows (higher VID codes correspond to lower voltages and lower VID codes correspond to higher voltages):

- If InputVid < MaxVid, OutputVid=MaxVid.
 - Else if (InputVid > MinVid) & (MinVid!=00h), OutputVid=MinVid.
 - Else OutputVid=InputVid.

This filtering is applied regardless of the source of the VID-change command.

2.5.1.3 Low Power Features

2.5.1.3.1 PSIX_L Bit

The processor can indicate whether or not it's in a low-voltage state via the PSIX_L bit. This indicator may be used by the voltage regulator to place itself into a more power efficient mode. PSIX_L is controlled independently for VDD and VDDNB.

- The processor supports the PSIO_L and the PSII_L bits in the data fields of the SVI2 command.
 - PSIO_L: PSIO_L for VDD and VDDNB is enabled using [D18F3xA0](#)[PsiVidEn] and [D18F5x17C](#)[NbPsi0VidEn], respectively. Once enabled, the state of PSIO_L is controlled by [D18F3xA0](#)[PsiVid[7:0]] and [D18F5x17C](#)[NbPsi0Vid]. Changes to the state of PSIO_L can only occur on VID changes.
 - PSII_L: The PSII_L bit for VDD and VDDNB is specified by [D18F5x12C](#)[CorePsi1En] and [D0F0xBC_x3F9EC](#)[EnableNbPsi1], respectively. See also [D18F5x188](#)[NbPsi1]. Changes to the state of PSII_L can occur at any time.

2.5.1.3.1.1 BIOS Requirements for PSIO_L

Enabling PSIO_L for the VDD and VDDNB planes depends on support from the voltage regulator and is therefore system specific. The voltage regulator must be able to supply the current required for the processor to operate at the VID code specified in [D18F3xA0](#)[PsiVid[7:0]] and [D18F5x17C](#)[NbPsi0Vid[7:0]]. Depending on the regulator used, AMD recommends one of the following methods:

- PSIO_L disabled:

- VDD: To set PSI0_L for the VDD plane, program [D18F3xA0](#)[PsiVidEn]=0.
- VDDNB: To set PSI0_L for the VDDNB plane, program [D18F5x17C](#)[NbPsi0VidEn]=0.
- PSI0_L set/clear based on current requirements:
 - VDD: The following algorithm describes how to program PSI0_L on VDD:

```

PSI_vrm_current = current at which the regulator allows PSI0_L.
previous_voltage = FFh

for (each P-state from P0 to D18F3xDC[HwPstateMaxVal]) {
    pstate_current = ProcIddMax for the current P-state,
                      see 2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\];
    pstate_voltage = MSRC001\_00[6B:64][CpuVid] of the current P-state;

    if (current P-state == D18F3xDC[HwPstateMaxVal]) {
        next_pstate_current = 0;
    } else {
        next_pstate_current = ProcIddMax for the next P-state,
                              see 2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\];
    }

    if ((pstate_current <= PSI_vrm_current) &&
        (next_pstate_current <= PSI_vrm_current) &&
        (pstate_voltage != previous_voltage)) {
        Program D18F3xA0[PsiVid] = pstate_voltage;
        Program D18F3xA0[PsiVidEn] = 1;
        break;
    }
    previous_voltage = pstate_voltage;
}

```

- VDDNB: The following algorithm describes how to program PSI0_L on VDDNB:

NbIddMax = [D18F5x16](#)[C:0][NbIddDiv] current.

PSI_vrm_current = current at which the VDDNB regulator allows PSI0_L.
previous_voltage = FFh

```

for (each valid NB P-state starting with NBP0) {
    pstate_current = NbIddMax of the current NB P-state;
    pstate_voltage = D18F5x16[C:0][NbVid] of the current NB P-state;

    if (current P-state is the last valid P-state) {
        next_pstate_current = 0;
    } else {
        next_pstate_current = NbIddMax for the next P-state;
    }

    if ((pstate_current <= PSI_vrm_current) &&
        (next_pstate_current <= PSI_vrm_current) &&
        (pstate_voltage != previous_voltage)) {
        Program D18F5x17C[NbPsi0Vid] = pstate_voltage;
        Program D18F5x17C[NbPsi0VidEn] = 1;
        break;
    }
    previous_voltage = pstate_voltage;
}

```


2.5.1.3.2 Low Power Voltages

In order to save power, voltages lower than those normally needed for operation may be applied to the VDD power plane while the processor is in a C-state or S-state. The lower voltage is defined as follows:

- PC6Vid: [D18F5x128](#)[PC6Vid] specifies a voltage that does not retain the CPU caches or the core microarchitectural state. PC6Vid does not allow execution and is only applied to the cores. See [2.5.3.2.3.4 \[Package C6 \(PC6\) State\]](#).

2.5.1.4 Voltage Transitions

The processor supports dynamic voltage transitions on the VDD and VDDNB planes. These transitions are requested by either hardware or software during state changes such as reset, P-state changes, and C-state changes. In all cases the VID code passed to the voltage regulator changes from the old value to the new value without stepping through intermediate values. The voltage regulator ramps the voltage directly from the starting voltage to the final voltage, no stepping occurs. See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

- If a voltage increase is requested, the processor waits the amount of time specified by [D18F5x12C](#)[WaitVidCompDis] before sending any additional voltage change requests to the voltage regulator or before beginning a frequency transition.
- If a voltage decrease is requested, the processor waits the amount of time specified by [D18F5x128](#)[FastSlamTimeDown] before sending any additional voltage change requests to the voltage regulator. For voltage decreases, the processor does not wait any time before beginning frequency changes.

The processor continues code execution during voltage changes when in the C0 state.

2.5.1.4.1 Hardware-Initiated Voltage Transitions

When software requests any of the following state changes, or hardware determines that any of the following state changes are necessary, hardware coordinates the necessary voltage changes:

- VDD:
 - Core P-state transition. See [2.5.3.1 \[Core P-states\]](#).
 - Package C-state transition. [D18F5x128](#)[PC6Vid] specifies a voltage that does not retain the CPU caches or the core microarchitectural state. PC6Vid does not allow execution and is only applied to the cores. See [2.5.3.2.3.4 \[Package C6 \(PC6\) State\]](#).
 - S-state transition. See [2.5.8.1 \[S-states\]](#).
- VDDNB:
 - NB P-state transition. See [2.5.4.1 \[NB P-states\]](#).
 - S-state transition. See [2.5.8.1 \[S-states\]](#).

2.5.1.4.2 Software-Initiated Voltage Transitions

2.5.1.4.2.1 Software-Initiated NB Voltage Transitions

Software can request voltage changes on the VDDNB power plane using the BIOSMC_MSG_VDDNB_REQUEST software interrupt. To make a voltage change request, software uses the sequence described in [2.13.1 \[Software Interrupts\]](#) with Service Index 3Ah.

Software voltage requests are considered by hardware when taking voltage plane dependencies into account (see [2.5.2.2 \[Dependencies Between Subcomponents on VDDNB\]](#)).

2.5.2 Frequency and Voltage Domain Dependencies

2.5.2.1 Dependencies Between Cores

Whenever a P-state or C-state is requested on a core (see [2.5.3.1 \[Core P-states\]](#) and [2.5.3.2 \[Core C-states\]](#)), hardware must take the following frequency and voltage domain dependencies into account when deciding whether to make the requested change:

- Cores within a compute unit share a common frequency and voltage domain.
- Compute units within a processor share a common voltage domain, but have independent frequency domains. The voltage is determined by the highest-performance P-state requested on any core.

As a result, the P-state and C-state change requests have the following results:

- If different compute units request different voltages, the VDD voltage is determined by the highest voltage (lowest VID) requested.
- If the cores within a compute unit request different P-states while in C0, frequency and voltage are determined by the highest-performance P-state requested.
- If both cores request non-C0 states, the behavior is specified by [D18F4x128\[CoreCstatePolicy\]](#).
- If one core within a compute unit requests a CC6 while the other core is in C0, the frequency and voltage of the compute unit is determined by the core in C0.
- If one core within a compute unit requests a CC6 while the other core is in C0, the core could independently enter CC6.

2.5.2.2 Dependencies Between Subcomponents on VDDNB

Many subcomponents of the processor reside on the VDDNB power plane. Hardware must take voltage domain dependencies into account when determining whether to make a voltage change requested by one of the subcomponents. Whenever a state transition occurs that causes a voltage change request (see [2.5.1.4.1 \[Hardware-Initiated Voltage Transitions\]](#)), or software makes a voltage change request (see [2.5.1.4.2 \[Software-Initiated Voltage Transitions\]](#)), the VDDNB voltage requested by the processor is determined by the highest voltage (lowest VID) request made by any of the subcomponents or by software.

2.5.2.3 BIOS Requirements for Power Plane Initialization

- Ensure the following fields are configured to their BIOS recommendations:
 - [D18F3xA0\[Svi2HighFreqSel\]](#).
 - [D18F3xD8\[VSRampSlamTime\]](#).
- Optionally configure PSIx_L. Refer to [2.5.1.3.1 \[PSIx_L Bit\]](#) for additional details.

2.5.3 CPU Power Management

2.5.3.1 Core P-states

Core P-states are operational performance states characterized by a unique combination of core frequency and voltage. The processor supports up to 8 core P-states (P0 through P7), specified in [MSRC001_00\[6B:64\]](#). Out of cold reset, the voltage and frequency of the compute units is specified by [MSRC001_0071\[StartupPstate\]](#).

Support for dynamic core P-state changes is indicated by more than one enabled selection in [MSRC001_00\[6B:64\]\[PstateEn\]](#). At least one enabled P-state (P0) is specified for all processors.

Software requests core P-state changes for each core independently using the hardware P-state control mechanism (a.k.a. fire and forget). Support for hardware P-state control is indicated by [CPUID](#)

Fn8000_0007_EDX[HwPstate]=1b. Software may not request any P-state transitions using the hardware P-state control mechanism until the P-state initialization requirements defined in [2.5.3.1.6 \[BIOS Requirements for Core P-state Initialization and Transitions\]](#) are complete.

The processor supports independently-controllable frequency planes for each compute unit and the NB; and independently-controllable voltage planes. See [2.5.1 \[Processor Power Planes And Voltage Control\]](#) for voltage plane definitions.

The following terms may be applied to each of these planes:

- FID: frequency ID. Specifies the PLL frequency multiplier, relative to the reference clock, for a given domain.
- DID: divisor ID. Specifies the post-PLL power-of-two divisor that can be used to reduce the operating frequency.
- COF: current operating frequency. Specifies the operating frequency as a function of the FID and DID. Refer to [CoreCOF](#) for the CPU COF formula and [NBCOF](#) for the NB COF formula.
- VID: voltage ID. Specifies the voltage level for a given domain. Refer to [2.5.1.2.1 \[MinVid and MaxVid Check\]](#) for encodings.

All FID and DID parameters for software P-states must be programmed to equivalent values for all cores and NBs in the coherent fabric. See [2.5.3.1.1.1 \[Software P-state Numbering\]](#). Refer to [MSRC001_00\[6B:64\]](#) and [D18F5x16\[C:0\]](#) for further details on programming requirements.

2.5.3.1.1 Core P-state Naming and Numbering

Since the number of boosted P-states may vary from product to product, the mapping between [MSRC001_00\[6B:64\]](#) and the indices used to request P-state changes or status also varies. In order to clarify this, two different numbering schemes are used.

2.5.3.1.1.1 Software P-state Numbering

When referring to software P-state numbering, the following naming convention is used:

- Non-boosted P-states are referred to as P0, P1, etc.
 - P0 is the highest power, highest performance, non-boosted P-state.
 - Each ascending P-state number represents a lower-power, lower performance non-boosted P-state than the prior P-state number.
- Boosted P-states are referred to as Pb0, Pb1, etc.
 - Pb0 is the highest-performance, highest-power boosted P-state.
 - Each higher numbered boosted P-state represents a lower-power, lower-performance boosted P-state.

For example, if [D18F4x15C](#)[NumBoostStates] contains the values shown below, then the P-states would be named as follows:

Table 10: Software P-state Naming

D18F4x15C[NumBoost-States]=1		D18F4x15C[NumBoost-States]=3	
P-state Name	Corresponding MSR Address	P-state Name	Corresponding MSR Address
Pb0	MSRC001_0064	Pb0	MSRC001_0064
P0	MSRC001_0065	Pb1	MSRC001_0065
P1	MSRC001_0066	Pb2	MSRC001_0066
P2	MSRC001_0067	P0	MSRC001_0067
P3	MSRC001_0068	P1	MSRC001_0068
P4	MSRC001_0069	P2	MSRC001_0069
P5	MSRC001_006A	P3	MSRC001_006A
P6	MSRC001_006B	P4	MSRC001_006B

All sections and register definitions use software P-state numbering unless otherwise specified.

2.5.3.1.1.2 Hardware P-state Numbering

When referring to hardware P-state numbering, the following naming convention is used:

- All P-states are referred to as P0, P1, etc.
 - P0 is the highest power, highest-performance P-state, regardless of whether it is a boosted P-state or a non-boosted P-state.
 - Each ascending P-state number represents a lower-power, lower-performance P-state, regardless of whether it is a boosted P-state or not.

2.5.3.1.2 Core P-state Control

Core P-states are dynamically controlled by software and are exposed through ACPI objects (refer to [2.5.3.1.8.3 \[ACPI Processor P-state Objects\]](#)). Software requests a core P-state change by writing a 3 bit index corresponding to the desired P-state number to [MSRC001_0062\[PstateCmd\]](#) of the appropriate core. For example, to request P3 for core 0 software would write 011b to core 0's [MSRC001_0062\[PstateCmd\]](#).

Boosted P-states may not be directly requested by software. Whenever software requests the P0 state on a processor that supports APM (i.e. writes 000b to [MSRC001_0062\[PstateCmd\]](#)), hardware dynamically places the core into the highest-performance P-state possible as determined by APM. See [2.5.9 \[Application Power Management \(APM\)\]](#).

Hardware sequences the frequency and voltage changes necessary to complete a P-state transition as specified by [2.5.3.1.5 \[Core P-state Transition Behavior\]](#) with no additional software interaction required. Hardware also coordinates frequency and voltage changes when differing P-state requests are made on cores that share a frequency or voltage plane. See [2.5.2 \[Frequency and Voltage Domain Dependencies\]](#) for details about hardware coordination.

Table 11: Software P-state Control

D18F4x15C[NumBoostStates]=1			D18F4x15C[NumBoostStates]=3		
P-state Name	Index Used for Requests/Status	Corresponding MSR Address	P-state Name	Index Used for Requests/Status	Corresponding MSR Address
Pb0	n/a	MSRC001_0064	Pb0	n/a	MSRC001_0064
P0	0	MSRC001_0065	Pb1	n/a	MSRC001_0065
P1	1	MSRC001_0066	Pb2	n/a	MSRC001_0066
P2	2	MSRC001_0067	P0	0	MSRC001_0067
P3	3	MSRC001_0068	P1	1	MSRC001_0068
P4	4	MSRC001_0069	P2	2	MSRC001_0069
P5	5	MSRC001_006A	P3	3	MSRC001_006A
P6	6	MSRC001_006B	P4	4	MSRC001_006B

Hardware controls the VID for each voltage domain according to the highest requirement of the frequency domain(s) on each plane. For example, the VID for a 4 compute unit dual-plane system must be maintained at the highest level required for all 4 frequency domains. The number of frequency domains in a voltage domain is package/platform specific. Refer to [2.5.3.1.5 \[Core P-state Transition Behavior\]](#) for details on hardware P-state voltage control. [2.5.2.3 \[BIOS Requirements for Power Plane Initialization\]](#) specifies the processor initialization requirements for voltage plane control.

2.5.3.1.3 Core P-state Visibility

[MSRC001_0063\[CurPstate\]](#) reflects the current non-boosted P-state number for each compute unit. For example, if [MSRC001_0063\[CurPstate\]=010b](#) on compute unit 1, then compute unit 1 is in the P2 state. If a compute unit is in a boosted P-state, [MSRC001_0063\[CurPstate\]](#) reads back as 0.

The voltage on a compute unit may not correspond to the VID code specified by the current P-state of the compute unit due to voltage plane dependencies. See [2.5.2 \[Frequency and Voltage Domain Dependencies\]](#). If a compute unit is in the P0 state (i.e. if [MSRC001_0063\[CurPstate\]=0](#)), the frequency of the compute unit could be the frequency specified by P0 or any boosted P-state. To determine the frequency of a compute unit, see [2.5.3.3 \[Effective Frequency\]](#).

2.5.3.1.4 Core P-state Limits

Core P-states may be limited to lower-performance values under certain conditions, including:

- HTC. See [D18F3x64\[HtcPstateLimit\]](#).
- Software. See [D18F3x68\[SwPstateLimit\]](#).
- Core Performance Boost. See [2.5.9 \[Application Power Management \(APM\)\]](#).
- PROCHOT_L assertion. See [2.10.3.1 \[PROCHOT_L and Hardware Thermal Control \(HTC\)\]](#).
- SMU. See [D18F4x13C\[SmuPstateLimit\]](#).

P-state limits are applied to all cores on the processor. The current P-state limit is provided in [MSRC001_0061\[CurPstateLimit\]](#). Changes to the [MSRC001_0061\[CurPstateLimit\]](#) can be programmed to trigger interrupts through [D18F3x64\[PslApicLoEn, PslApicHiEn\]](#). In addition, the maximum P-state value, regardless of the source, is limited as specified in [MSRC001_0061\[PstateMaxVal\]](#).

2.5.3.1.5 Core P-state Transition Behavior

The following rules specify how P-states changes function and interact with other system or processor states:

- If the P-state number is increasing (the compute unit is moving to a lower-performance state), then the COF is changed first, followed by the VID change. If the P-state number is decreasing, then the VID is changed first followed by the COF.
- When the processor initiates a VID change that increases voltage for a voltage domain, no new voltage or frequency changes occur until [D18F3xD8\[VSRampSlamTime\]](#) has expired, regardless of whether any new requests are received. When the processor initiates a VID change that decreases voltage for a voltage domain, new voltage or frequency changes are allowed to occur immediately.
 - This is true regardless of whether the frequency or voltages changes occur as a result of P-state or C-state changes.
- If multiple commands are issued that affect the P-state of a domain prior to when the processor initiates the change of the P-state of that domain, then the processor operates on the last one issued.
- Once a P-state change starts, the P-state state machine (PSSM) continues through completion unless interrupted by a PWROK deassertion. If multiple P-state changes are requested concurrently, the PSSM may group the associated VID changes separately from the associated COF changes.
- Behavior during RESET_L assertions:
 - All cores are transitioned to C0.
 - VDD VID is transitioned to HWP0 VID. See [MSRC001_0064\[CpuVid\]](#).
 - If there is no P-state transition activity, then the compute units and NB remain in the current P-state.
 - If a RESET_L assertion interrupts a P-state transition, then the COF remains in it's current state at the time RESET_L is asserted (either the value of the old or the new P-state). BIOS is required to transition to valid COF and VID settings after a warm reset according to the sequence defined in [2.5.3.1.8 \[BIOS COF and VID Requirements After Warm Reset\]](#).
 - After a warm reset [MSRC001_0063 \[P-state Status\]](#) is consistent with [MSRC001_0071\[CurPstate\]](#). [MSRC001_0062 \[P-state Control\]](#) may not be consistent with [MSRC001_0071\[CurPstate\]](#).
- The OS controls the P-state through [MSRC001_0062 \[P-state Control\]](#), independent of P-state limits described in [D18F3x64\[HtcPstateLimit\]](#), [D18F3x68\[SwPstateLimit\]](#). P-state limits interact with OS-directed P-state transitions as follows:
 - Of all the active P-state limits, the one that represents the lowest-performance P-state number, at any given time, is treated as an upper limit on performance.
 - As the limit becomes active or inactive, or if it changes, the P-state for each compute unit is placed in either the last OS-requested P-state or the new limit P-state, whichever is a lower performance P-state number.
 - If the resulting P-state number exceeds [MSRC001_0061\[PstateMaxVal\]](#), regardless of whether it is a limit or OS-requested, then the PstateMaxVal is used instead.

2.5.3.1.6 BIOS Requirements for Core P-state Initialization and Transitions

1. Check that [CPUID Fn8000_0007_EDX\[HwPstate\]](#)=1. If not, P-states are not supported, no P-state related ACPI objects should be generated, and BIOS must skip the rest of these steps.
2. Complete the [2.5.2.3 \[BIOS Requirements for Power Plane Initialization\]](#).
3. Ensure the following fields are configured to their BIOS recommendations:
 - [D18F3xA0\[PiILockTime\]](#).
 - [D18F3xD4\[PowerStepUp, PowerStepDown\]](#).
4. Transition all cores to the minimum performance P-state using the algorithm detailed in [2.5.3.1.8.2 \[Core Minimum P-state Transition Sequence After Warm Reset\]](#).
5. Complete the [2.5.4.1.2.1 \[NB P-state COF and VID Synchronization After Warm Reset\]](#). All cores on a processor must be in the minimum performance P-state prior to executing this sequence.

6. Complete the [2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\]](#).
7. Perform the following steps in any order:
 - A. Enable [2.5.9 \[Application Power Management \(APM\)\]](#) as follows:
 - Ensure the following fields are configured to their BIOS recommendations:
 - [D18F4x110\[CSampleTimer\]](#).
 - [D18F4x15C\[ApmMasterEn\]](#).
 - [D18F5xE0\[RunAvgRange\]](#).
 - See your AMD representative for details on how to enable the GPU aspects of [2.5.9 \[Application Power Management \(APM\)\]](#).
 - If [D18F4x15C\[NumBoostStates\] != 0](#), program [D18F4x15C\[BoostSrc\] = 1](#).
 - B. Transition all cores to the maximum performance P-state by writing 0 to [MSRC001_0062\[PstateCmd\]](#).
 - C. Create ACPI objects if necessary:
 - Determine the valid set of P-states as indicated by [MSRC001_00\[6B:64\]\[PstateEn\]](#).
 - If P-states are not supported, as indicated by only one enabled selection in [MSRC001_00\[6B:64\]\[PstateEn\]](#), then BIOS must not generate ACPI-defined P-state objects described in [2.5.3.1.8.3 \[ACPI Processor P-state Objects\]](#). Otherwise, the ACPI objects should be generated to enable P-state support.
 - D. Configure the COF and VID for each processor appropriately based on the sequence described in [2.5.4.1.2 \[BIOS NB P-state Configuration\]](#).
8. Configure [PSIx_L](#). Refer to [2.5.1.3.1 \[PSIx_L Bit\]](#) for additional details.

2.5.3.1.7 Processor-Systemboard Power Delivery Compatibility Check

BIOS must disable processor P-states that require higher power delivery than the systemboard can support. This power delivery compatibility check is designed to prevent system failures caused by exceeding the power delivery capability of the systemboard for the power plane(s) that contain the core(s). Refer to [2.5.1 \[Processor Power Planes And Voltage Control\]](#) for power plane definitions and configuration information. BIOS can optionally notify the user if P-states are detected that exceed the systemboard power delivery capability. Modifications to [MSRC001_00\[6B:64\]\[P-state \[7:0\]\]](#) must be applied equally to all cores on the same node. This check does not ensure functionality for all package/socket compatible processor/systemboard combinations.

[MSRC001_00\[6B:64\]\[PstateEn\]](#) must be set to 0 for any P-state MSR where [PstateEn=1](#) and the processor current requirement ([ProcIddMax](#)), defined by the following equation, is greater than the systemboard current delivery capability.

$$\text{ProcIddMax} = \text{MSRC001_00[6B:64][IddValue]} \text{ current} * 1/10^{\text{MSRC001_00[6B:64][IddDiv]}} * (\text{D18F5x84[CmpCap]} + 1)$$

The power delivery check should be applied starting with hardware P0 and continue with increasing P-state indexes (1, 2, 3, and 4) for all enabled P-states. Once a compatible P-state is found using the [ProcIddMax](#) equation the check is complete. All processor P-states with higher indexes are defined to be lower power and performance, and are therefore compatible with the systemboard.

Example:

- [MSRC001_0065\[IddValue\]](#) = 32d
- [MSRC001_0065\[IddDiv\]](#) = 0d
- [D18F5x84\[CmpCap\]](#) = 1d
- [ProcIddMax](#) = 32 * 1 * 2 = 64A per plane

The systemboard must be able to supply $\geq 64\text{A}$ for the unified core power plane in order to support P1 for this

processor. If the systemboard current delivery capability is < 64A per plane then BIOS must set `MSRC001_0065[PstateEn]=0` for all cores on this node, and continue by checking P2 in the same fashion.

If no P-states are disabled while performing the power delivery compatibility check then BIOS does not need to take any action.

If at least one P-state is disabled by performing the power delivery compatibility check and at least one P-state remains enabled, then BIOS must perform the following steps:

1. If the P-state pointed to by `MSRC001_0063[CurPstate]` is disabled by the power delivery compatibility check, then BIOS must request a transition to an enabled P-state using `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
2. Copy the contents of the enabled P-state MSR (`MSRC001_00[6B:64]`) to the highest performance P-state locations. E.g. if P0 and P1 are disabled by the power delivery compatibility check and P2 - P4 remain enabled, then the contents of P2 - P4 should be copied to P0 - P2 and P3 and P4 should be disabled (`PstateEn=0`). This step uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].
3. Request a P-state transition to the P-state MSR containing the COF/VID values currently applied. E.g. If `MSRC001_0063[CurPstate]=100b` and P4 P-state MSR information is copied to P2 in step 2, then BIOS should write 010b to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
4. If a subset of boosted P-states are disabled, then copy the contents of the P-state MSR pointed to by the highest performance boosted P-state that is enabled to the P-state MSRs pointed to by the boosted P-states that are disabled.
5. If all boosted P-states are disabled, then program `D18F4x15C[BoostSrc]=0`.
6. Adjust the following P-state parameters affected by the P-state MSR copy by subtracting the number of software P-states that are disabled by the power delivery compatibility check. This calculation should not wrap, but saturate at 0. E.g. if P0 and P1 are disabled, then each of the following register fields should have 2 subtracted from them:
 - `D18F3x64[HtcPstateLimit]`
 - `D18F3x68[SwPstateLimit]`
 - `D18F3xDC[HwPstateMaxVal]`

If any node has all P-states disabled after performing the power delivery compatibility check, then BIOS must perform the following steps. This does not ensure operation and BIOS should notify the user of the incompatibility between the processor and systemboard if possible.

1. If `MSRC001_0063[CurPstate] != MSRC001_0061[PstateMaxVal]`, then write `MSRC001_0061[PstateMaxVal]` to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
2. If `MSRC001_0061[PstateMaxVal] != 000b` copy the contents of the P-state MSR pointed to by `MSRC001_0061[PstateMaxVal]` to `MSRC001_0064` and set `MSRC001_0064[PstateEn]`; Write 000b to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value. This step uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].
3. Adjust the following fields to 000b.
 - `D18F3x64[HtcPstateLimit]`
 - `D18F3x68[SwPstateLimit]`
 - `D18F3xDC[HwPstateMaxVal]`
4. Program `D18F4x15C[BoostSrc]=0`.

2.5.3.1.8 BIOS COF and VID Requirements After Warm Reset

Warm reset is asynchronous and can interrupt P-state transitions leaving the processor in a VID state that does not correspond to `MSRC001_0063[CurPstate]` on any core. The processor frequency after warm reset

corresponds to [MSRC001_0063\[CurPstate\]](#). See [2.5.3.1.5 \[Core P-state Transition Behavior\]](#) for P-state transition behavior when RESET_L is asserted. BIOS is required to transition the processor to valid COF and VID settings corresponding to an enabled P-state following warm reset. The cores may be transitioned to either the maximum or minimum P-state COF and VID settings using the sequences defined in [2.5.3.1.8.1 \[Core Maximum P-state Transition Sequence After Warm Reset\]](#) and [2.5.3.1.8.2 \[Core Minimum P-state Transition Sequence After Warm Reset\]](#). Transitioning to the minimum P-state after warm reset is recommended to prevent undesired system behavior if a warm reset occurs before the [2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\]](#) is complete. BIOS is not required to manipulate NB COF and VID settings following warm reset if the warm reset was issued by BIOS to update [D18F5x16\[C:0\]\[NbFid\[5:0\]\]](#).

2.5.3.1.8.1 Core Maximum P-state Transition Sequence After Warm Reset

1. If [MSRC001_0071\[CurPstate\]](#) = [D18F3xDC\[HwPstateMaxVal\]](#), then skip step 3 for that core.
2. Write [MSRC001_0061\[PstateMaxVal\]](#) to [MSRC001_0062\[PstateCmd\]](#) on all cores in the processor.
3. Wait for [MSRC001_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
4. Wait for [MSRC001_0071\[CurCpuVid\]](#) = [CurCpuVid] from [MSRC001_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
5. All previous steps must be completed on all cores prior to continuing the sequence since a compute unit transitions to the highest performance P-state requested on either core.
6. Write 0 to [MSRC001_0062\[PstateCmd\]](#) on all cores in the processor.
7. Wait for [MSRC001_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001_00\[6B:64\]](#) indexed by [MSRC001_0071\[CurPstateLimit\]](#).
8. If [MSRC001_0071\[CurPstateLimit\]](#) != [D18F3xDC\[HwPstateMaxVal\]](#), wait for [MSRC001_0071\[CurCpuVid\]](#) = [CpuVid] from [MSRC001_00\[6B:64\]](#) indexed by [MSRC001_0071\[CurPstateLimit\]](#).
9. Wait for [MSRC001_0063\[CurPstate\]](#) = [MSRC001_0061\[CurPstateLimit\]](#).

2.5.3.1.8.2 Core Minimum P-state Transition Sequence After Warm Reset

1. If [MSRC001_0071\[CurPstate\]](#) = [MSRC001_0071\[CurPstateLimit\]](#), then skip step 3 for that core.
2. Write 0 to [MSRC001_0062\[PstateCmd\]](#) on all cores in the processor.
3. Wait for [MSRC001_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001_00\[6B:64\]](#) indexed by [MSRC001_0071\[CurPstateLimit\]](#).
4. Write [MSRC001_0061\[PstateMaxVal\]](#) to [MSRC001_0062\[PstateCmd\]](#) on all cores in the processor.
5. Wait for [MSRC001_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
6. If [MSRC001_0071\[CurPstateLimit\]](#) != [MSRC001_0071\[CurPstate\]](#), wait for [MSRC001_0071\[CurCpuVid\]](#) = [CpuVid] from [MSRC001_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
7. Wait for [MSRC001_0063\[CurPstate\]](#) = [MSRC001_0062\[PstateCmd\]](#).

2.5.3.1.8.3 ACPI Processor P-state Objects

Processor performance control is implemented through the _PCT, _PSS and _PSD objects in ACPI 2.0 and later revisions. The presence of these objects indicates to the OS that the platform and processor are capable of supporting multiple performance states. Processor performance states are not supported with ACPI 1.0b. BIOS must provide the _PCT, _PSS, and _PSD objects, and define other ACPI parameters to support operating systems that provide native support for processor P-state transitions.

The following rules apply to BIOS generated ACPI objects in multi-core systems. Refer to the appropriate

ACPI specification for additional details:

- All cores must expose the same number of performance states to the OS.
- The respective performance states displayed to the OS for each core must have identical performance and power-consumption parameters (e.g. P0 on core 0 must have the same performance and power-consumptions parameters as P0 on core 1, P1 on core 0 must have the same parameters as P1 on core 1, however P0 can be different than P1).
- Performance state objects must be present under each processor object in the system.

2.5.3.1.8.3.1 **_PCT (Performance Control)**

BIOS must declare the performance control object parameters as functional fixed hardware. This definition indicates the processor driver understands the architectural definition of the P-state interface associated with [CPUID Fn8000_0007_EDX\[HwPstate\]=1](#).

- Perf_Ctrl_Register = Functional Fixed Hardware
- Perf_Status_Register = Functional Fixed Hardware

2.5.3.1.8.3.2 **_PSS (Performance Supported States)**

A unique **_PSS** entry is created for each non-boosted P-state. The value contained in the **_PSS** Control field is written to [MSRC001_0062 \[P-state Control\]](#) to request a P-state change to the CoreFreq of the associated **_PSS** object. The value contained in [MSRC001_0063 \[P-state Status\]](#) can be used to identify the **_PSS** object of the current P-state request by equating [MSRC001_0063\[CurPstate\]](#) to the value of the Status field. See [2.5.3.1 \[Core P-states\]](#).

BIOS loops through each of [MSRC001_00\[6B:64\]](#) applying the following formulas to create the fields for the **_PSS** object for for each valid P-state (see [MSRC001_00\[6B:64\]\[PstateEn\]](#)). BIOS skips over any P-state MSRs that specify boost P-states (see [D18F4x15C\[NumBoostStates\]](#)).

- CoreFreq (MHz) = Calculated using the formula for [CoreCOF](#).
- Power (mW) = [MSRC001_00\[6B:64\]\[CpuVid\]](#) voltage * [MSRC001_00\[6B:64\]\[IddValue\]](#) current * 1000.
- TransitionLatency (us) and BusMasterLatency (us):
 - If [MSRC001_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is the same for all enabled P-states (see [MSRC001_00\[6B:64\]\[PstateEn\]](#)) and all boosted P-states:
 - TransitionLatency = BusMasterLatency = (15 steps * [D18F3xD4\[PowerStepDown\]](#) time * 1000 us/ns) + (15 steps * [D18F3xD4\[PowerStepUp\]](#) time * 1000 us/ns)
 - Else if [MSRC001_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is different for any enabled (see [MSRC001_00\[6B:64\]\[PstateEn\]](#)) or boost P-states:
 - TransitionLatency = BusMasterLatency = (15 steps * [D18F3xD4\[PowerStepDown\]](#) time * 1000 us/ns) + [D18F3xA0\[PllLockTime\]](#) time + (15 steps * [D18F3xD4\[PowerStepUp\]](#) time * 1000 us/ns)
 - Example:
 - [MSRC001_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is not the same for all P-states
 - [D18F3xD4\[PowerStepDown\]](#) = [D18F3xD4\[PowerStepUp\]](#) = 8h (50 ns/step)
 - [D18F3xA0\[PllLockTime\]](#) = 001b (2 us)
 - TransitionLatency = BusMasterLatency = (15 steps * 50 ns/step / 1000 us/ns) + 2us + (15 steps * 50 ns/step / 1000 us/ns) = 3.5 us (round up to 4 us)
- Control/Status:
 - The highest performance non-boosted P-state must have the **_PSS** control and status fields programmed to 0.
 - Any lower performance non-boosted P-states must have the **_PSS** control and status fields programmed

in ascending order.

2.5.3.1.8.3.3 **_PPC (Performance Present Capabilities)**

The _PPC object is optional. Refer to the ACPI specification for details on use and content.

2.5.3.1.8.3.4 **_PSD (P-state Dependency)**

AMD recommends the ACPI 3.0 _PSD object be generated for each core as follows to cause the cores to transition between P-states independently:

- NumberOfEntries = 5.
- Revision = 0.
- Domain = CPUID Fn0000_0001_EBX[LocalApicId[7:2]].
- CoordType = FEh. (HW_ALL)
- NumProcessors = 4.

2.5.3.1.8.4 **Fixed ACPI Description Table (FADT) Entries**

Declare the following FADT entries:

- PSTATE_CNT = 00h.
- DUTY_WIDTH = 00h.

2.5.3.1.8.5 **XPSS (Microsoft® Extended PSS) Object**

Some Microsoft® operating systems require an XPSS object to make P-state changes function properly. A BIOS that implements an XPSS object has special requirements for the _PCT object. See the Microsoft *Extended PSS ACPI Method Specification* for the detailed requirements to implement these objects.

2.5.3.2 **Core C-states**

C-states are processor power states. C0 is the operational state in which instructions are executed. All other C-states are low-power states in which instructions are not executed. When coming out of warm and cold reset, the processor is transitioned to the C0 state.

2.5.3.2.1 **C-state Names and Numbers**

C-states are often referred to by an alphanumeric naming convention, C1, C2, C3, etc. The mapping between ACPI defined C-states and AMD specified C-states is not direct. AMD specified C-states are referred to as IO-based C-states. Up to three IO-based C-states are supported, IO-based C-state 0, 1, and 2. The IO-based C-state index corresponds to the offset added to [MSRC001_0073\[CstateAddr\]](#) to initiate a C-state request. See [2.5.3.2.2 \[C-state Request Interface\]](#). The actions taken by the processor when entering a low-power C-state are configured by software. See [2.5.3.2.3 \[C-state Actions\]](#) for information about AMD specific actions.

2.5.3.2.2 **C-state Request Interface**

C-states are dynamically requested by software and are exposed through ACPI objects (see [2.5.3.2.6 \[ACPI Processor C-state Objects\]](#)). C-states can be requested on a per-core basis. Software requests a C-state change in one of two ways:

- Reading from an IO address: The IO address must be the address specified by [MSRC001_0073\[CstateAddr\]](#) plus an offset of 0 through 7. The processor always returns 0 for this IO read. Offsets 2 through 7 result in an offset of 2.

- Executing the HLT instruction. This is equivalent to reading from the IO address specified by [D18F4x128\[HaltCstateIndex\]](#).

When software requests a C-state transition, hardware evaluates any frequency and voltage domain dependencies and determines which C-state actions to execute. See [2.5.2 \[Frequency and Voltage Domain Dependencies\]](#) and [2.5.3.2.3 \[C-state Actions\]](#).

2.5.3.2.3 C-state Actions

A core takes one of several different possible actions based upon a C-state change request from software. The C-state action fields are defined in [D18F4x11\[C:8\]](#).

2.5.3.2.3.1 C-state Probes and Cache Flushing

If probes occur after a core enters a non-C0 state, and the caches are not flushed by hardware, the core clock may be ramped back up to the C0 frequency to service the probes, as specified by [D18F4x118/D18F4x11C\[CpuPrbEn\]](#).

If a core enters a non-C0 state and cache flush is enabled (see [D18F3xDC\[CacheFlushOnHaltCtl\]](#) and [D18F4x118/D18F4x11C\[CacheFlushEn\]](#)), a timer counts down for a programmable period of time as specified by [D18F3xDC\[CacheFlushOnHaltTmr\]](#) or [D18F4x118/D18F4x11C\[CacheFlushTmrSel\]](#). When the timer expires, the core flushes its L1 cache to L2 cache and the core clocks are ramped down to a divisor specified by [D18F3xDC\[CacheFlushOnHaltCtl\]](#). The timer is reset if the core exits the C-state for any reason. See [2.5.3.2.4.1 \[Cache Flush On Halt Saturation Counter\]](#).

Once a core flushes its caches, probes are no longer sent to that core. This improves probing performance for cores that are in C0.

2.5.3.2.3.2 Core C1 (CC1) State

When a core enters the CC1 state, its clock ramps down to the frequency specified by [D18F4x118/D18F4x11C\[ClkDivisorCstAct\]](#).

2.5.3.2.3.3 Core C6 (CC6) State

A core can gate off power to its internal logic when it enters any non-C0 state. This power gated state is known as CC6. In order to enter CC6, hardware first enters CC1 then checks [D18F4x118/D18F4x11C\[PwrGateEnCstAct\]](#). Power gating reduces the amount of power consumed by the core. VDD voltage is not reduced when a core is in CC6. The following sequence occurs when a core enters the CC6 state:

1. If [MSRC001_0071\[CurPstate\]](#) < [D18F3xA8\[PopDownPstate\]](#), transition the core P-state to [D18F3xA8\[PopDownPstate\]](#).
2. Internal core state is saved to L1 cache.
3. L1 cache is flushed to L2 cache. See [2.5.3.2.3.1 \[C-state Probes and Cache Flushing\]](#).
4. Power is removed from the core and the core PLL/voltage regulator is powered down as specified by [D18F5x128\[CC6PwrDwnRegEn\]](#).

All of the following must be true in order for a core to be placed into CC6:

- [D18F4x118/D18F4x11C\[CacheFlushEn\]](#)=1 for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[CacheFlushTmrSel\]](#) != 11b for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[PwrGateEnCstAct\]](#)=1 for the corresponding C-state action field.
- [D18F2x118\[CC6SaveEn\]](#)=1.

- [D18F2x118\[LockDramCfg\]=1](#) .
- The CC6 storage area in DRAM is configured. See [2.9.11 \[DRAM CC6/PC6 Storage\]](#).

The events which cause a core to exit the CC6 state are specified in [2.5.3.2.5 \[Exiting C-states\]](#).

If a warm reset occurs while a core is in CC6, all MCA registers in the core shown in [Table 75](#) are cleared to 0. See [2.16.1 \[Machine Check Architecture\]](#).

The time required to enter and exit CC6 is directly proportional to the core P-state frequency. Slower core frequencies require longer entry and exit times. Latency issues may occur with core P-state frequencies less than 800MHz.

2.5.3.2.3.4 Package C6 (PC6) State

When all cores enter a non-C0 state, VDD can be reduced to a non-operational voltage that does not retain core state. This state is known as PC6 and reduces the amount of static and dynamic power consumed by all cores.

The following actions are taken by hardware prior to PC6 entry:

1. If [MSRC001_0071\[CurPstate\] < D18F3xA8\[PopDownPstate\]](#), transition the core P-state to [D18F3xA8\[PopDownPstate\]](#).
2. For all cores not in CC6, internal core state is saved to L1 cache .
3. For all cores not in CC6, L1 cache is flushed to L2 cache. See [2.5.3.2.3.1 \[C-state Probes and Cache Flushing\]](#).
4. VDD is transitioned to the VID specified by [D18F5x128\[PC6Vid\]](#).
5. If the core PLLs are not powered down during CC6 entry (see [2.5.3.2.3.3 \[Core C6 \(CC6\) State\]](#)), then they are powered down as specified by [D18F5x128\[PC6PwrDwnRegEn\]](#).

All of the following must be true on all cores in order for a package to be placed into PC6:

- [D18F4x118/D18F4x11C\[CacheFlushEn\]=1](#) for the corresponding C-state action field
- [D18F4x118/D18F4x11C\[CacheFlushTmrSel\] != 11b](#) for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[PwrOffEnCstAct\]=1](#) for the corresponding C-state action field.
- [D18F2x118\[CC6SaveEn\]=1](#).
- [D18F2x118\[LockDramCfg\]=1](#).

2.5.3.2.4 C-state Request Monitors

Deeper C-states have higher entry and exit latencies but provide greater power savings than shallower C-states. To help balance the performance and power needs of the system, the processor can limit access to specific C-states in certain scenarios.

2.5.3.2.4.1 Cache Flush On Halt Saturation Counter

A cache flush success monitor tracks the success rate of cache flush timer expirations relative to the core exiting a C-state. Based on the success rate, caches may be flushed immediately without waiting for the cache flush timer to expire. See [D18F4x128\[CacheFlushSucMonThreshold\]](#). When the core resumes normal execution, the caches refill as normal.

2.5.3.2.5 Exiting C-states

The following events may cause the processor to exit a non-C0 C-state and return to C0:

- INTR
- NMI

- SMI
- INIT
- RESET_L assertion

If an INTR is received while a core is in a non-C0 C-state, the state of EFLAGS[IF] and the mechanism used to enter the non-C0 C-state determine the actions taken by the processor.

- Entry via HLT, EFLAGS[IF]==0: The interrupt does not wake up the core.
- Entry via HLT, EFLAGS[IF]==1: The interrupt wakes the core and the core begins execution at the interrupt service routine.
- Entry via IO read, EFLAGS[IF]==0: The interrupt wakes the core and the core begins execution at the instruction after the IN instruction that was used to enter the non-C0 C-state.
- Entry via IO read, EFLAGS[IF]==1: The interrupt wakes the core and the core begins execution at the interrupt service routine.

2.5.3.2.6 ACPI Processor C-state Objects

Processor power control is implemented through the `_CST` object in ACPI 2.0 and later revisions. The presence of the `_CST` object indicates to the OS that the platform and processor are capable of supporting multiple power states. BIOS must provide the `_CST` object and define other ACPI parameters to support operating systems that provide native support for processor C-state transitions. See [2.5.3.2.6.1 \[_CST\]](#).

The `_CST` object is not supported with ACPI 1.0b. BIOS should provide FADT entries to support operating systems that are not compatible with ACPI 2.0 and later revisions. See [2.5.3.2.6.2 \[_CRS\]](#).

2.5.3.2.6.1 _CST

The `_CST` object should be generated for each core as follows:

- Count = 1.
- Register = [MSRC001_0073](#)[CstateAddr] + 1.
- Type = 2.
- Latency = 400.
- Power = 0.

2.5.3.2.6.2 _CRS

BIOS must declare in the root host bridge `_CRS` object that the IO address range from [MSRC001_0073](#)[CstateAddr] to [MSRC001_0073](#)[CstateAddr]+7 is consumed by the host bridge.

2.5.3.2.6.3 Fixed ACPI Description Table (FADT) Entries

Declare the following FADT entries:

- P_LVL2_LAT = 100.
- P_LVL3_LAT = 1001.
- FLAGS.PROC_C1 = 1.
- FLAGS.P_LVL2_UP = 1.

Declare the following P_BLK entries:

- P_LVL2 = [MSRC001_0073](#)[CstateAddr] + 1.
- P_LVL3 = 0.

BIOS must declare the PSTATE_CNT entry as 00h.

2.5.3.2.7 BIOS Requirements for Initialization

1. Initialize [MSRC001_0073](#)[CstateAddr] with an available IO address. See [2.5.3.2.6.2](#) [[_CRS](#)].
2. Initialize [D18F4x11](#)[C:8].
3. Generate ACPI objects as described in [2.5.3.2.6](#) [[ACPI Processor C-state Objects](#)].

2.5.3.3 Effective Frequency

The effective frequency interface allows software to discern the average, or effective, frequency of a given core over a configurable window of time. This provides software a measure of actual performance rather than forcing software to assume the current frequency of the core is the frequency of the last P-state requested. This can be useful when the P-state is limited by:

- HTC
- [D18F3x68](#)[SwPstateLimit]
- SBI
- CPB

The following procedure calculates effective frequency using [MSR0000_00E7](#) [[Max Performance Frequency Clock Count \(MPERF\)](#)] and [MSR0000_00E8](#) [[Actual Performance Frequency Clock Count \(APERF\)](#)]:

1. At some point in time, write 0 to both MSRs.
2. At some later point in time, read both MSRs.
3. Effective frequency = (value read from [MSR0000_00E8](#) / value read from [MSR0000_00E7](#)) * P0 frequency using software P-state numbering.

Additional notes:

- The amount of time that elapses between steps 1 and 2 is determined by software.
- It is software's responsibility to disable interrupts or any other events that may occur in between the write of [MSR0000_00E7](#) and the write of [MSR0000_00E8](#) in step 1 or between the read of [MSR0000_00E7](#) and the read of [MSR0000_00E8](#) in step 2.
- The behavior of [MSR0000_00E7](#) and [MSR0000_00E8](#) may be modified by [MSRC001_0015](#)[[EffFreqCntMwait](#)].
- The effective frequency interface provides +/- 50MHz accuracy if the following constraints are met:
- Effective frequency is read at most one time per millisecond.
- When reading or writing [MSR0000_00E7](#) and [MSR0000_00E8](#) software executes only MOV instructions, and no more than 3 MOV instructions, between the two RDMSR or WRMSR instructions.
- [MSR0000_00E7](#) and [MSR0000_00E8](#) are invalid if an overflow occurs.

2.5.4 NB Power Management

2.5.4.1 NB P-states

The processor supports up to four NB P-states (NBP0 through NBP3), specified in [D18F5x16](#)[C:0]. Each NB P-state consists of the following:

- Enable: [D18F5x16](#)[C:0][NbPstateEn].
- NCLK frequency: [D18F5x16](#)[C:0][NbFid[5:0], NbDid].
- VDDNB voltage: [D18F5x16](#)[C:0][NbVid].
- Memory P-state: [D18F5x16](#)[C:0][MemPstate]. See [2.5.7.1](#) [[Memory P-states](#)].

Out of cold reset, the NB P-state is specified by [D18F5x174](#)[StartupNbPstate] and [D18F3xA0](#)[CofVidProg]. The current NB P-state is specified by [D18F5x174](#)[CurNbFid[5:0], CurNbDid, {CurNbVid[7],

CurNbVid[6:0]]).

Although four NB P-states are defined, only two NB P-states are used at any given time, specified by [D18F5x170](#)[NbPstateHi, NbPstateLo].

2.5.4.1.1 NB P-state Transitions

Hardware selects whether to use the high or low NB P-state based on several criteria as follows:

- Core P-state:
 - [MSRC001_00](#)[6B:64][NbPstate].
 - [D18F5x170](#)[NbPstateThreshold].
- Memory Bandwidth Utilization
 - SMU monitors memory bandwidth utilization and forces NB P-state to high or low state.
- Display/Multimedia Memory Bandwidth Requirements
 - Depending on the memory bandwidth requirements to support multimedia clients, driver may send messages to the SMU to prevent or allow entry into the low NB P-state. For example, depending on the display resolution, display may require higher memory bandwidth and hence, may drive the requirement for NB P-state high.
- Hysteresis timer:
 - [D18F5x170](#)[NbPstateHiRes, NbPstateLoRes].
- The following configuration registers:
 - [D18F5x170](#)[SwNbPstateLoDis, NbPstateDisOnP0].
 - [MSRC001_0071](#)[NbPstateDis].

Once the NB determines that an NB P-state transition is necessary, the NB executes the following sequence:

1. If transitioning from the low NB P-state to the high NB P-state, transition VDDNB voltage.
2. If the GPU is enabled as specified by [D18F5x178](#)[SwGfxDis], wait for display buffer to fill.
3. Quiesce all active cores.
4. If the internal GPU is enabled as specified by [D18F5x178](#)[SwGfxDis], wait for display buffer to fill.
5. Stop memory traffic and place DRAM into self-refresh.
6. Transition NCLK frequency.
7. Update NB P-state specific DRAM settings within hardware, see [D18F2x210_dct\[0\]_nbp\[3:0\]](#).
8. Take DRAM out of self-refresh and allow memory traffic.
9. Wake up cores.
10. If transitioning from the high NB P-state to the low NB P-state, transition VDDNB voltage.

2.5.4.1.2 BIOS NB P-state Configuration

2.5.4.1.2.1 NB P-state COF and VID Synchronization After Warm Reset

BIOS performs the following sequence on one core. This is done after any warm reset and before [2.9.7 \[DCT/DRAM Initialization and Resume\]](#).

1. Temp1=[D18F5x170](#)[SwNbPstateLoDis].
2. Temp2=[D18F5x170](#)[NbPstateDisOnP0].
3. Temp3=[D18F5x170](#)[NbPstateThreshold].
4. Temp4=[D18F5x170](#)[NbPstateGnbSlowDis].
5. If [MSRC001_0070](#)[NbPstate]=0, go to step 6. If [MSRC001_0070](#)[NbPstate]=1, go to step 11.

6. Write 1 to [D18F5x170\[NbPstateGnbSlowDis\]](#).
7. Write 0 to [D18F5x170\[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateThreshold\]](#).
8. Wait for [D18F5x174\[CurNbPstate\] = D18F5x170\[NbPstateLo\]](#) and [D18F5x174\[CurNbFid\[5:0\], CurNbDid\]=\[NbFid\[5:0\], NbDid\]](#) from [D18F5x16\[C:0\]](#) indexed by [D18F5x170\[NbPstateLo\]](#).
9. Set [D18F5x170\[SwNbPstateLoDis\]=1](#).
10. Wait for [D18F5x174\[CurNbPstate\] = D18F5x170\[NbPstateHi\]](#) and [D18F5x174\[CurNbFid\[5:0\], CurNbDid\]=\[NbFid\[5:0\], NbDid\]](#) from [D18F5x16\[C:0\]](#) indexed by [D18F5x170\[NbPstateHi\]](#). Go to step 15.
11. Write 1 to [D18F5x170\[SwNbPstateLoDis\]](#).
12. Wait for [D18F5x174\[CurNbPstate\] = D18F5x170\[NbPstateHi\]](#) and [D18F5x174\[CurNbFid\[5:0\], CurNbDid\]=\[NbFid\[5:0\], NbDid\]](#) from [D18F5x16\[C:0\]](#) indexed by [D18F5x170\[NbPstateHi\]](#).
13. Write 0 to [D18F5x170\[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateThreshold\]](#).
14. Wait for [D18F5x174\[CurNbPstate\] = D18F5x170\[NbPstateLo\]](#) and [D18F5x174\[CurNbFid\[5:0\], CurNbDid\]=\[NbFid\[5:0\], NbDid\]](#) from [D18F5x16\[C:0\]](#) indexed by [D18F5x170\[NbPstateLo\]](#).
15. Set [D18F5x170\[SwNbPstateLoDis\]=Temp1](#), [D18F5x170\[NbPstateDisOnP0\]=Temp2](#), and [D18F5x170\[NbPstateThreshold\]=Temp3](#), and [D18F5x170\[NbPstateGnbSlowDis\]=Temp4](#).

2.5.4.1.2.2 NB P-state Transitions

During boot when [D18F5x174\[NbPstateDis\]=0](#), BIOS forces the processor to the desired NB P-states using the following steps:

1. Save the values in [D18F5x170](#) for later restoration to unforce the NB P-state.
2. Set the desired NB P-state pointers, [D18F5x170\[NbPstateHi, NbPstateLo\]](#).
3. Transition to the desired state as follows:
 - In order to transition to [D18F5x170\[NbPstateHi\]](#), program [D18F5x170](#) as follows:
 - [SwNbPstateLoDis](#) = 1.
 - Wait for [D18F5x174\[CurNbPstate\]](#) to equal [NbPstateHi](#).
 - In order to transition to [D18F5x170\[NbPstateLo\]](#), program [D18F5x170](#) as follows:
 - [SwNbPstateLoDis](#) = [NbPstateDisOnP0](#) = [NbPstateThreshold](#) = 0.
 - Wait for [D18F5x174\[CurNbPstate\]](#) to equal [NbPstateLo](#).

BIOS performs the following to release the NB P-state force:

4. Release the NB P-state force by restoring initial [D18F5x170](#) values.
 - Restore the initial [D18F5x170\[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateLo\]](#) values.
 - Restore the initial [D18F5x170\[NbPstateThreshold, NbPstateHi\]](#) values.

2.5.4.1.2.3 NB P-state Configuration for Runtime

Please see your AMD representative for details.

2.5.4.2 NB C-states

NB C-states are package-level actions that occur only when all cores enter a non-C0 state (see [2.5.3.2 \[Core C-states\]](#)). The NB C-state actions are:

- DRAM self-refresh (see [2.5.7.2 \[DRAM Self-Refresh\]](#)):
 - Enable bit: [D18F4x118/D18F4x11C\[SelfRefr\]](#).
 - Entry requirements:
 - No outstanding GPU traffic or traffic from a link.
 - Exit conditions (any of the following must be true):

- The local APIC timer expires. See 2.4.8.1 [Local APIC].
 - New GPU traffic or traffic from a link.
 - A P-state limit update (see 2.5.3.1.4 [Core P-state Limits]) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.
- NB clock gating:
 - Enable bit: D18F4x118/D18F4x11C[NbClkGate].
 - Entry requirements:
 - No outstanding GPU traffic or traffic from a link.
 - Exit conditions (any of the following must be true):
 - The local APIC timer expires. See 2.4.8.1 [Local APIC].
 - New GPU traffic or traffic from a link.
 - A P-state limit update (see 2.5.3.1.4 [Core P-state Limits]) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.
 - NB power gating:
 - Enable bit: D18F4x118/D18F4x11C[NbPwrGate].
 - Entry requirements (all of the following must be true):
 - No outstanding GPU traffic or traffic from a link.
 - All cores are in CC6.
 - DRAM is either in or entering self-refresh.
 - Exit conditions (any of the following must be true):
 - The local APIC timer expires. See 2.4.8.1 [Local APIC].
 - New GPU traffic or traffic from a link.
 - A P-state limit update (see 2.5.3.1.4 [Core P-state Limits]) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.

When entering NB C-states, the actions are taken in the following order:

1. DRAM self-refresh.
2. NB clock gating.
3. NB power gating.

When exiting NB C-states, the actions are taken in the following order:

1. NB power gating.
2. NB clock gating.
3. DRAM self-refresh.

2.5.5 Bandwidth Requirements

- The frequency relationship of (core COF / NB COF) ≤ 6 must be maintained for all supported P-state combinations. E.g., a core P0 COF of 4.0 GHz could not be combined with a NB P0 COF of 0.6 GHz; the NB P0 COF would have to be 0.8 GHz or greater; if the NB P0 COF is 1.2 GHz, then the NB P1 COF of 0.6 GHz may only be supported if the corresponding core P-state specify a COF of 3.0 GHz or less.
- All core P-states are required to be defined such that (NB COF/core COF) ≤ 32 , for all NB/core P-state combinations. E.g., if the NB COF is 4.8 GHz then the core COF must be no less than 150 MHz.
- All core P-states must be defined such that CoreCOF ≥ 600 MHz.
- NB COF \geq MEMCLK frequency.
- 400MHz \leq NB COF \leq 1600MHz.
- NB COF $\leq 2 \times$ MEMCLK frequency.

2.5.6 GPU and Root Complex Power Management

2.5.6.1 Dynamic Power Management (DPM)

The processor supports dynamic GPU frequency changes along with VDDNB voltage change requests, known as Dynamic Power Management (DPM). Once initialized, hardware dynamically monitors processor utilization and adjusts the frequencies and voltage based on that utilization. For DPM, higher numbered states represent higher performance and lower numbered states represent lower performance.

2.5.6.1.1 Activity Monitors

The processor contains activity monitors which track the usage level of different processor subcomponents. A binary signal from each subcomponent is used to determine whether that subcomponent is busy. On each clock cycle, the activity monitor samples the signal from each unmasked subcomponent.

See [D0F0xBC_xC020_0110](#) for LCLK DPM activity monitor.

The output of the activity monitor is then used to determine whether the DPM state should be changed.

2.5.6.1.2 SCLK DPM

SCLK DPM consists of up to 8 states. Any number of states up through 8 may be used and there is no requirement that the states be contiguous.

2.5.6.1.3 LCLK DPM

LCLK DPM consists of up to 8 states. Any number of states up through 8 may be used and there is no requirement that the states be contiguous. Each state is made up of the following parameters.

- Valid bit: [D0F0xBC_x3FD\[8C:00:step14\]\[StateValid\]](#).
- Voltage change hysteresis threshold: [D0F0xBC_x3FD\[8C:00:step14\]\[LowVoltageReqThreshold\]](#).
- Divisor: [D0F0xBC_x3FD\[8C:00:step14\]\[LclkDivider\]](#).
- VID: [D0F0xBC_x3FD\[8C:00:step14\]\[VID\]](#).
 - See [2.5.2.2 \[Dependencies Between Subcomponents on VDDNB\]](#).
- State change hysteresis thresholds: [D0F0xBC_x3FD\[94:08:step14\]\[HysteresisUp, HysteresisDown\]](#).
- Activity thresholds: [D0F0xBC_x3FD\[9C:10:step14\]\[ActivityThreshold\]](#).
- Residency counter: See [D0F0xBC_x3FD\[94:08:step14\]\[ResidencyCounter\]](#).

LCLK DPM is enabled by setting [D0F0xBC_x3FDC8\[LclkDpmEn\]](#). LCLK DPM voltage changes are enabled using [D0F0xBC_x3FDC8\[VoltageChgEn\]](#). When LCLK DPM is first enabled, the DPM state is transitioned to [D0F0xBC_x3FDC8\[LclkDpmBootState\]](#).

2.5.6.2 GPU and Root Complex Power Gating

Several subcomponents of the GPU and root complex can be power gated when not in use.

- GPU:** GPU power gating is initialized and enabled by software (see [GpuEnabled](#) and [D0F0x7C\[ForceIntGfxDisable\]](#)). Once initialized and enabled, the GPU is power gated by hardware when inactive and is ungated by hardware when needed. When internal GPU is disabled by BIOS, BIOS is responsible for power gating the GPU.

- **UVD:** UVD is power gated by software when not in use and is ungated by software when needed. UVD's internal state is not saved and UVD goes through an internal reset when power is restored.
- **GMC:** GMC power gating is initialized and enabled by software. Once initialized and enabled, GMC is power gated by hardware when inactive and is ungated by hardware when needed. GMC's state is saved internally. If the internal GPU is disabled, either by hardware (fusing) or by software, software is responsible for power gating GMC.
- **VCE:** VCE is power gated by software when not in use and is ungated by software when needed. VCE's internal state is not saved and VCE goes through an internal reset when power is restored.
- **DCE:** DCE is power gated by software when there is no display connected. DCE's internal state is not saved and DCE goes through an internal reset when power is restored.
- **PCIe®:** Any core that does not contain the UMI link can be power gated when it is not in use. In addition, the individual phys on the TX and RX sides of each link can be power gated when the links are not connected. During POST and runtime, several software components inform the SMU whether the link core or the link phys are in use. SMU power gates or ungates the link core and the link phys as needed.

2.5.7 DRAM Power Management

2.5.7.1 Memory P-states

The processor supports up to 2 memory P-states, M0 and M1. Each memory P-state consists of the following:

- MEMCLK frequency
- A set of frequency dependent DRAM timing and configuration registers

See [2.9 \[DRAM Controllers \(DCTs\)\]](#) for DRAM technology specific information and requirements.

All valid memory P-states are associated with a specific NB P-state, as specified by [D18F5x16\[C:0\]\[MemPstate\]](#). When hardware transitions to a new NB P-state, the memory P-state is transitioned to that specified by the new NB P-state.

Out of cold reset the current memory P-state is M0. The P-state value specified by [D18F5x16\[C:0\]\[MemPstate\]](#) of the NB P-state indexed by [D18F5x174\[StartupNbPstate\]](#) is invalid. Support for dynamic memory P-state changes is indicated by [D18F3xE8\[MemPstateCap\]=1](#) and one or more [D18F5x16\[C:0\]\[MemPstate\]=1](#); otherwise M0 is used by hardware for configuration purposes.

During boot, and if [D18F5x170\[MemPstateDis\]=0](#), the BIOS can disable memory P-states using the following steps:

1. Program [D18F5x170\[MemPstateDis\]=1](#).
2. Program [D18F5x16\[C:0\]\[MemPstate\]=0](#).

2.5.7.2 DRAM Self-Refresh

DRAM is placed into self-refresh on S3 entry (see [2.5.8.1.1 \[ACPI Suspend to RAM State \(S3\)\]](#)).

In addition to S3, DRAM is placed into self-refresh in S0 in the following two scenarios:

- NB P-state transitions (see [2.5.4.1 \[NB P-states\]](#)).
- NB C-states (see [2.5.4.2 \[NB C-states\]](#)).

The following requirements must be met before hardware places DRAM into self-refresh:

- No pending traffic.
- One of the following is true:
 - The GPU is idle and the internal display buffer is full.
 - The internal GPU is disabled.

Once the above requirements are met, hardware places DRAM into self-refresh.

Early self-refresh occurs when DRAMs are placed in self-refresh before expiration of the cache flush timer. See [D18F4x118/D18F4x11C\[SelfRefrEarly\]](#) and [D18F5x128\[SelfRefrEarlyDis\]](#). If early self-refresh is enabled, the DRAMs are taken out of self-refresh to perform the flush operation when the cache flush timer expires and then placed back into self-refresh.

The following are events that cause DRAM to transition out of self-refresh:

- Core transitioning to C0.
- Incoming request from any link or the GMC
- P-state limit update, only in the case when all cores are not in the power gated (CC6) state.

To save additional power, hardware always tristates MEMCLK when entering self-refresh.

2.5.7.3 Stutter Mode

DRAM is most commonly placed in self-refresh due to stutter mode when the internal GPU is in use. The display buffer in the GPU is a combination of a large buffer known as the DMIF (Display Memory Interface FIFO) and a smaller line buffer. The DMIF takes data originating from DRAM and sends it to the line buffer to draw to the screen. When the data level in the DMIF is full, DRAM is placed in self-refresh, and incoming DRAM requests are queued. As the DMIF drains, it eventually falls below a predefined watermark level, at which point hardware pulls DRAM out of self-refresh and services all the requests in the queue. Once all the requests are complete and the DMIF is full again, a transition back into self-refresh occurs if the stutter mode conditions are still met.

2.5.7.3.1 System BIOS Requirements for Stutter Mode Operation During POST

BIOS creates a data structure in memory containing information about the processor for use by the driver. Please see your AMD representative for more information.

2.5.7.4 EVENT_L

EVENT_L is a level sensitive input to the processor. When asserted, the actions specified by [D18F2xA4](#) are taken. EVENT_L is generally asserted to indicate that a DRAM high temperature condition exists. The minimum assertion time for EVENT_L is 15 ns. The minimum deassertion time for EVENT_L is 15 ns.

- EVENT_L is pulled to VDDIO on the motherboard.
- EVENT_L is ignored while:
 - PWROK is de-asserted.
 - RESET_L is asserted.
- BIOS must ensure that throttling is disabled (see [D18F2xA4\[CmdThrottleMode\]](#)) until DRAM training is complete.

See [2.9.12 \[DRAM On DIMM Thermal Management and Power Capping\]](#).

2.5.8 System Power Management

2.5.8.1 S-states

S-states are ACPI defined sleep states. S0 is the operational state. All other S-states are low-power states in which various voltage rails in the system may or may not be powered. See the ACPI specification for descriptions of each S-state. The only other S-state supported is S5.

2.5.8.1.1 ACPI Suspend to RAM State (S3)

The processor supports the ACPI-defined S3 state. Software is responsible for restoring the state of the processor's registers when resuming from S3. All registers in the processor that BIOS initialized during the initial boot must be restored. The method used to restore the registers is system specific.

During S3 entry, software is responsible for transitioning the processor to Memory Pstate0. See [2.5.7.1 \[Memory P-states\]](#).

During S3 entry, system memory enters self-refresh mode (see [2.5.7.2 \[DRAM Self-Refresh\]](#)). Software is responsible for bringing memory out of self-refresh mode when resuming from S3. To bring memory out of self-refresh mode. See [2.9.7 \[DCT/DRAM Initialization and Resume\]](#).

Many of the systemboard power planes for the processor are powered down during S3. Refer to the Electrical Data Sheet for the following:

- Power plane electrical requirements during S3.
- Power plane sequencing requirements on S3 entry and exit.
- System signal states for both inputs (e.g. PWROK and RESET_L) and outputs (e.g. VID[*], PSI_L bit, THERMTRIP_L, etc.) during S3.
- System signal sequencing requirements on S3 entry and exit.
- System management message sequencing on S3 entry and exit.

2.5.9 Application Power Management (APM)

Application Power Management (APM) allows the processor to deterministically provide maximum performance while remaining within the specified power delivery and removal envelope. APM dynamically monitors processor activity and generates an approximation of power consumption. If power consumption exceeds a defined power limit, a P-state limit is applied by APM hardware to reduce power consumption. APM ensures that average power consumption over a thermally significant time period remains at or below the defined power limit. This allows P-states to be defined with higher frequencies and voltages than could be used without APM.

2.5.9.1 Core Performance Boost (CPB)

These P-states are referred to as boosted P-states.

- Support for APM is specified by [CUID Fn8000_0007_EDX\[CPB\]](#).
- APM is enabled if all of the following conditions are true:
 - [MSRC001_0015\[CpbDis\]](#) = 0 for all cores.
 - [D18F4x15C\[ApmMasterEn\]](#) = 1.
 - [D18F4x15C\[BoostSrc\]](#) = 01b.
 - [D18F4x15C\[NumBoostStates\]](#) != 0.
- APM can be dynamically enabled and disabled through [MSRC001_0015\[CpbDis\]](#). If core performance

boost (CPB) is disabled, a P-state limit is applied. The P-state limit restricts cores to the highest performance non-boosted P-state.

- All P-states, both boosted and non-boosted, are specified in [MSRC001_00\[6B:64\]](#).
- The number of boosted P-states is specified by [D18F4x15C\[NumBoostStates\]](#).
 - The number of boosted P-states may vary from product to product.
- Two levels of boosted P-states are supported. Compute units can be placed in the first level of boosted P-states if the processor power consumption remains within the TDP limit. The second level of boosted P-states is C-state Boost. See [2.5.9.1.1 \[C-state Boost\]](#).
- All boosted P-states are always higher performance than non-boosted P-states.
- To ensure proper operation, boosted P-states should be hidden from the operating system. BIOS should not provide ACPI _PSS entries for boosted P-states. See [2.5.3.1.8.3.2 \[_PSS \(Performance Supported States\)\]](#).
- The lowest-performance P-state CPB limits the processor to is the highest-performance non-boosted P-state.

2.5.9.1.1 C-state Boost

C-state Boost can only be achieved if a subset of cores/compute units are in CC6 and the processor power consumption remains within the TDP limit. See [D18F4x16C\[CstateCnt, CstateBoost, CstateCores\]](#).

2.5.9.2 TDP Limiting

TDP limiting is a mechanism for capping the power consumption of the processor through a TDP limit.

2.5.9.3 Bidirectional Application Power Management (BAPM)

Bidirectional Application Power Management (BAPM) is an algorithm to enable fine grained power transfers between the core and GPU.

2.5.10 Battery Based Boost (BBB)

Battery Based Boost allows boosting the part on DC/battery mode while also keeping a check on the battery life and avoiding excessive battery drain. On BBB enabled parts, boost on battery will be enabled by default. OEMs can choose to disable BBB by setting the BLDCFG parameter BLDCFG_BATTERY_BOOST_EN to 0.

2.6 Performance Monitoring

The processor includes support for two methods of monitoring processor performance:

- [2.6.1 \[Performance Monitor Counters\]](#).
- [2.6.2 \[Instruction Based Sampling \(IBS\)\]](#).

2.6.1 Performance Monitor Counters

The following types of performance counters are supported:

- [2.6.1.1 \[Core Performance Monitor Counters\]](#), consisting of one set located in each core of each compute unit.
- [2.6.1.2 \[L2I Performance Monitor Counters\]](#), consisting of one set located in each compute unit.
- [2.6.1.3 \[NB Performance Monitor Counters\]](#), consisting of one set located in each node.

The accuracy of the performance counters is not ensured. The performance counters are not assured of producing identical measurements each time they are used to measure a particular instruction sequence, and they should not be used to take measurements of very small instruction sequences. The RDPMC instruction is not serializing, and it can be executed out-of-order with respect to other instructions around it. Even when bound by serializing instructions, the system environment at the time the instruction is executed can cause events to be counted before the counter value is loaded into EDX:EAX.

To accurately start counting with the write that enables the counter, disable the counter when changing the event and then enable the counter with a second MSR write.

Writing the performance counters can be useful if there is an intention for software to count a specific number of events, and then trigger an interrupt when that count is reached. An interrupt can be triggered when a performance counter overflows. Software should use the WRMSR instruction to load the count as a two's-complement negative number into the performance counter. This causes the counter to overflow after counting the appropriate number of times.

In addition to the RDMSR instruction, the performance counter registers can be read using a special read performance-monitoring counter instruction, RDPMC.

2.6.1.1 Core Performance Monitor Counters

The core performance monitor counters are used by software to count specific non L2 events that occur in a core of the compute unit. Each core of each compute unit provides four 48-bit performance counters. Unless otherwise specified, the events count only the activity of the core, not activity caused by the other core of the compute unit.

[MSRC001_00\[03:00\]](#) specify the events to be monitored and how they are monitored. All of the events are specified in [3.23 \[Core Performance Counter Events\]](#). [MSRC001_00\[07:04\]](#) are the counters.

All of the events are specified in [3.23 \[Core Performance Counter Events\]](#).

2.6.1.2 L2I Performance Monitor Counters

The L2I performance monitor counters are used by software to count specific L2 events that occur in a core of the compute unit. Unless otherwise specified using the thread masks, the events count the activity of all cores. Each compute unit provides four 48-bit performance counters.

[MSRC001_023\[6,4,2,0\] \[L2I Performance Event Select \(L2I_PERF_CTL\[3:0\]\)\]](#) specify the events to be mon-

itored and how they are monitored. [MSRC001_023\[7,5,3,1\]](#) [L2I Performance Event Counter ([L2I_PERF_CTR\[3:0\]](#))] are the counters. Support for [MSRC001_023\[7:0\]](#) is indicated by [CPUID Fn8000_0001_ECX\[PerfCtrExtL2I\]](#).

All of the events are specified in [3.24 \[L2I Performance Counter Events\]](#).

All L2I performance monitor events can be counted on all counters.

All L2I performance events are one event per clock.

2.6.1.3 NB Performance Monitor Counters

The NB performance monitor counters are used by software to count specific events that occur in the NB. Each node provides four 48-bit performance counters. Since the northbridge performance counter register are shared by all cores on a node, monitoring of northbridge events should only be performed by one core on a node.

These counters are 48 bits. This requires two 32 bit reads to get the entire value. The high bits are not latched when the low bits are read. This means that it is possible for the low bits to overflow into the high bits between the two reads. Software can read the registers multiple times in the sequence below to ensure the proper value is read.

1. Read the low bits (31:0), call the result Lo0.
2. Read the high bits (47:32), call the result Hi0.
3. Read the low bits again, call the result Lo1.
4. Read the high bits again, call the result Hi1.
5. If $Hi1 = Hi0$, a roll over did not occur and $\{Hi0, Lo0\}$ is valid.
6. If $Hi1 \neq Hi0$, a roll over may have occurred. If so, read again to get Hi2 and Lo2.
7. If $Hi2 = Hi1$, then $\{Hi1, Lo1\}$ is a valid counter value.

[MSRC001_024\[6,4,2,0\]](#) [Northbridge Performance Event Select ([NB_PERF_CTL\[3:0\]](#))] and [MSRC001_024\[7,5,3,1\]](#) [Northbridge Performance Event Counter ([NB_PERF_CTR\[3:0\]](#))] specify the events to be monitored and how they are monitored. Support for [MSRC001_024\[7:0\]](#) is indicated by [CPUID Fn8000_0001_ECX\[PerfCtrExtNB\]](#).

All of the events are specified in [3.25 \[NB Performance Counter Events\]](#).

All NB performance monitor events can be counted on all counters.

All NB performance events are one event per clock.

NB performance counters do not support APIC interrupt capability.

2.6.2 Instruction Based Sampling (IBS)

IBS is a code profiling mechanism that enables the processor to select a random instruction fetch or micro-op after a programmed time interval has expired and record specific performance information about the operation. An interrupt is generated when the operation is complete as specified by [MSRC001_103A \[IBS Control\]](#). An interrupt handler can then read the performance information that was logged for the operation.

The IBS mechanism is split into two parts: instruction fetch performance controlled by [MSRC001_1030 \[IBS](#)

Fetch Control (IbsFetchCtl)]; and instruction execution performance controlled by **MSRC001_1033 [IBS Execution Control (IbsOpCtl)]**. Instruction fetch sampling provides information about instruction TLB and instruction cache behavior for fetched instructions. Instruction execution sampling provides information about micro-op execution behavior. The data collected for instruction fetch performance is independent from the data collected for instruction execution performance. Support for the IBS feature is indicated by the **CPUID Fn8000_0001_ECX[IBS]**.

Instruction fetch performance is profiled by recording the following performance information for the tagged instruction fetch:

- If the instruction fetch completed or was aborted. See **MSRC001_1030**.
- The number of clock cycles spent on the instruction fetch. See **MSRC001_1030**.
- If the instruction fetch hit or missed the IC, hit/missed in the L1 and L2 TLBs, and page size. See **MSRC001_1030**.
- The linear address, physical address associated with the fetch. See **MSRC001_1031**, **MSRC001_1032**.

Instruction execution performance is profiled by tagging one micro-op associated with an instruction. Instructions that decode to more than one micro-op return different performance data depending upon which micro-op associated with the instruction is tagged. These micro-ops are associated with the RIP of the next instruction to retire. The following performance information is returned for the tagged micro-op:

- Branch and execution status for micro-ops. See **MSRC001_1035**.
- Branch target address for branch micro-ops. See **MSRC001_103B**.
- The logical address associated with the micro-op. See **MSRC001_1034**.
- The linear and physical address associated with a load or store micro-op. See **MSRC001_1038**, **MSRC001_1039**.
- The data cache access status associated with the micro-op: DC hit/miss, DC miss latency, TLB hit/miss, TLB page size. See **MSRC001_1037**.
- The number clocks from when the micro-op was tagged until the micro-op retires. See **MSRC001_1035**.
- The number clocks from when the micro-op completes execution until the micro-op retires. See **MSRC001_1035**.
- Source information for DRAM and MMIO. See **MSRC001_1036**.

2.7 Configuration Space

PCI-defined configuration space was originally defined to allow up to 256 bytes of register space for each function of each device; these first 256 bytes are called base configuration space (BCS). It was expanded to support up to 4096 bytes per function; bytes 256 through 4095 are called extended configuration space (ECS). The processor includes configuration space registers located in both BCS and ECS. Processor configuration space is accessed through bus 0, devices 18h to 1Fh, where device 18h corresponds to node 0 and device 1Fh corresponds to node 7. See **2.7.3 [Processor Configuration Space]**.

Configuration space is accessed by the processor through two methods:

- IO-space configuration: IO instructions to addresses CF8h and CFCh.
 - Enabled through **IOCF8[ConfigEn]**, which allows access to BCS.
 - Access to ECS enabled through **MSRC001_001F[EnableCf8ExtCfg]**.
 - Use of IO-space configuration can be programmed to generate GP faults through **MSRC001_0015[IoCfgGpFault]**.
 - SMI trapping for these accesses is specified by **MSRC001_0054 [IO Trap Control (SMI_ON_IO_TRAP_CTL_STS)]** and **MSRC001_00[53:50] [IO Trap (SMI_ON_IO_TRAP_[3:0])]**.

- MMIO configuration: configuration space is a region of memory space.
 - The base address and size of this range is specified by [MSRC001_0058 \[MMIO Configuration Base Address\]](#). The size is controlled by the number of configuration-space bus numbers supported by the system. Accesses to this range are converted configuration space as follows:
 - Address[31:0] = {0h, bus[7:0], device[4:0], function[2:0], offset[11:0]}.

The BIOS may use either configuration space access mechanism during boot. Before booting the OS, BIOS must disable IO access to ECS, enable MMIO configuration and build an ACPI defined MCFG table. BIOS ACPI code must use MMIO to access configuration space.

Per the link specification, BCS accesses utilize link addresses starting at FD_FE00_0000h and ECS accesses utilize link addresses starting at FE_0000_0000h.

2.7.1 MMIO Configuration Coding Requirements

MMIO configuration space accesses must use the uncacheable (UC) memory type.

Instructions used to read MMIO configuration space are required to take the following form:

```
mov eax/ax/al, any_address_mode;
```

Instructions used to write MMIO configuration space are required to take the following form:

```
mov any_address_mode, eax/ax/al;
```

No other source/target registers may be used other than eax/ax/al.

In addition, all such accesses are required not to cross any naturally aligned DW boundary. Access to MMIO configuration space registers that do not meet these requirements result in undefined behavior.

2.7.2 MMIO Configuration Ordering

Since MMIO configuration cycles are not serializing in the way that IO configuration cycles are, their ordering rules relative to posted may result in unexpected behavior.

Therefore, processor MMIO configuration space is designed to match the following ordering relationship that exists naturally with IO-space configuration: if a core generates a configuration cycle followed by a posted-write cycle, then the posted write is held in the processor until the configuration cycle completes. As a result, any unexpected behavior that might have resulted if the posted-write cycle were to pass MMIO configuration cycle is avoided.

2.7.3 Processor Configuration Space

The processor includes configuration space as described in [3 \[Registers\]](#). Accesses to unimplemented registers of implemented functions are ignored: writes dropped; reads return 0. Accesses to unimplemented functions also ignored: writes are dropped; however, reads return all F's. The processor does not log any master abort events for accesses to unimplemented registers or functions.

Accesses to device numbers of devices not implemented in the processor are routed based on the configuration map registers. If such requests are master aborted, then the processor can log the event.

2.8 Northbridge (NB)

Each node includes a single northbridge that provides the interface to the local core(s), the interface to system memory, and the interface to system IO devices. The NB includes all power planes except VDD; see [2.5.1 \[Processor Power Planes And Voltage Control\]](#).

The NB is responsible for routing transactions sourced from cores and link to the appropriate core, cache, DRAM, or link. See [2.4.6 \[System Address Map\]](#).

2.8.1 NB Architecture

Major NB blocks are: System Request Interface (SRI), Memory Controller (MCT), DRAM Controllers (DCTs), and crossbar (XBAR). SRI interfaces with the core(s). MCT maintains cache coherency and interfaces with the DCTs; MCT maintains a queue of incoming requests called MCQ. XBAR is a switch that routes packets between SRI, MCT, and the link.

The MCT operates on physical addresses. Before passing transactions to the DCTs, the MCT converts physical addresses into *normalized* addresses that correspond to the values programmed into [D18F2x\[5C:40\]_dct\[0\] \[DRAM CS Base Address\]](#). Normalized addresses include only address bits within the DCTs' range.

2.8.2 NB Routing

2.8.2.1 Address Space Routing

There are four main types of address space routed by the NB:

1. Memory space targeting system DRAM
2. Memory space targeting IO (MMIO)
3. IO space
4. Configuration space.

2.8.2.1.1 DRAM and MMIO Memory Space

Memory space transactions provide the NB with the physical address, cacheability type, access type, and DRAM/MMIO destination type as specified in section [2.4.6.1.2 \[Determining The Access Destination for Core Accesses\]](#).

Memory-space transactions are handled by the NB as follows:

- IO-device accesses are compared against:
 - If the access matches [D18F1x\[2CC:2A0,1CC:180,BC:80\] \[MMIO Base/Limit\]](#), then the transaction is routed to the root complex;
 - Else, if the access matches [D18F1x\[17C:140,7C:40\] \[DRAM Base/Limit\]](#), then the access is routed to the DCT;
 - Else, the access is routed to the UMI.
- For core accesses the routing is determined based on the DRAM/MMIO destination:
 - If the destination is DRAM:
 - If the access matches [D18F1x\[17C:140,7C:40\] \[DRAM Base/Limit\]](#), then the transaction is routed to the DCT;
 - Else, the access is routed to the UMI.
 - If the destination is MMIO:
 - If the access matches the VGA-compatible MMIO address space and [D18F1xF4\[VE\]=1](#) then [D18F1xF4](#) describes how the access is routed and controlled;
 - Else, If the access matches [D18F1x\[2CC:2A0,1CC:180,BC:80\] \[MMIO Base/Limit\]](#), then the transaction is routed to the root complex;

- Else, the access is routed to the UMI.

2.8.2.1.2 IO Space

IO-space transactions from IO links or cores are routed as follows:

- If the access matches [D18F1x\[DC:C0\] \[IO-Space Base/Limit\]](#), then the transaction is routed to the root complex;
- Else, If the access matches the VGA-compatible IO address space and [D18F1xF4\[VE\]=1](#) then [D18F1xF4](#) describes how the access is routed and controlled.
- Else, the access is routed to the UMI.

2.8.2.1.3 Configuration Space

Configuration-space transactions from IO links are master aborted. Configuration-space transactions from cores are routed as follows:

- If the access matches [D18F1x\[1DC:1D0,EC:E0\] \[Configuration Map\]](#), then the transaction is routed to the specified link;
- Else, the access is routed to link that contains compatibility (subtractive) address space.

2.8.2.1.3.1 Recommended Buffer Count Settings Overview

When changing from the recommended settings, see the register programming requirements in the definition of each register. Some chipsets may further optimize these settings for their platform. If values other than the recommended settings are used, see the register requirements in the definition of each register. [Table 12](#) defines commonly used terms for the following tables.

Table 12: ONION Link Definitions

Term	Definition
LinkGanged	Ganged = 0.
IOMMU	Indicates the presence of an IOMMU device on the IOH. IOMMU uses the isochronous flow control channel. If an IOMMU is present, D18F0x[84][IsocEn] must be set for all links.
IFCM	Isochronous Flow Control Mode. IFCM = D18F0x[84][IsocEn].

2.8.3 Memory Scrubbers

The processor includes memory scrubbers specified in [MSRC001_10A0](#), [D18F3x58](#), [D18F3x5C](#), and [D18F3x60](#). The scrubbers ensure that all cachelines in memory within or connected to the processor are periodically read and, if correctable errors are discovered, they are corrected.

For recommendations on scrub rates, see [2.16.1.8 \[Scrub Rate Considerations\]](#).

The scrub rate is specified as the time between successive scrub events. A scrub event occurs when a line of memory is checked for errors; the amount of memory that is checked varies based on the memory block (see field descriptions).

The time required to fully scrub the memory of a node is determined as:

- $\text{Time} = ((\text{memory size in bytes})/64) * (\text{Scrub Rate})$.
- E.g. If a node contains 1GB of system memory and $\text{DramScrub}=5.24 \text{ ms}$, then all of the system memory of the node is scrubbed about once every 23 hours.

2.9 DRAM Controllers (DCTs)

The processor includes one DRAM controller (DCT). Each DCT controls one 64-bit DDR3 DRAM channel.

A DRAM channel consists of the group of DRAM interface pins connecting to one series of DIMMs.

BIOS reads [D18F5x84\[DctEn\]](#) to determine the DCT to DDR channel mapping as follows:

- DCT0 controls channel A.

The DCTs operate on normalized addresses corresponding to the values programmed into [D18F2x\[5C:40\]_dct\[0\]](#). Normalized addresses only include address bits within a DCT's range. The physical to normalized address translation varies based on various Northbridge settings. See [2.9.10 \[Memory Hoisting\]](#) and [2.9.11 \[DRAM CC6/PC6 Storage\]](#).

The following restrictions limit the DIMM types and configurations supported by the DCT:

- All DIMMs connected to a node are required to operate at the same MEMCLK frequency, regardless of the channel. All DCTs of a node must be programmed to the same frequency.
- Mixing of DIMM types within a system is not supported.
- RDIMM, LRDIMM, and stacked DRAM type DIMMs are not supported.
- Mixing of ECC and non-ECC DIMMs within a system is not supported

2.9.1 Common DCT Definitions

Table 13: DCT Definitions

Term	Definition								
AutoSelfRefresh	DDR3 SPDByte[31][2] of the DIMM being configured.								
DataMaskMbType	Motherboard type for processor Data Mask pins. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No connect</td></tr> <tr> <td>01b</td><td>Pins are routed per DM rules</td></tr> <tr> <td>10b</td><td>Pins are routed per DQS rules</td></tr> </table>	Bits	Description	00b	No connect	01b	Pins are routed per DM rules	10b	Pins are routed per DQS rules
Bits	Description								
00b	No connect								
01b	Pins are routed per DM rules								
10b	Pins are routed per DQS rules								
DdrRate	The DDR data rate (MT/s) as specified by D18F2x94_dct[0][MemClkFreq] and D18F2x2E0_dct[0][M1MemClkFreq] .								
DeviceWidth	DDR3 SPDByte[7][2:0] of the DIMM being configured.								
DIMM	The DIMM being configured								
DIMM0	DIMM slots 0-n. The DIMMs on each channel are numbered from 0 to n where DIMM0 is the DIMM closest to the processor on that channel and DIMMn is the DIMM farthest from the processor on that channel.								
DIMM1									
DimmsPopulated	The number of DIMMs populated per channel plus rows of Solder-down DRAM devices.								
DllPDBypassMode	DDR phy DLL power down and bypass mode. Requires a Solder-down DRAM configuration following delay matched motherboard design guidelines.								
DR	Dual Rank								
DramCapacity	DDR3 SPDByte[4][3:0] of the DIMM being configured.								
ExtendedTemperature-Range	DDR3 SPDByte[31][0] of the DIMM being configured.								

Table 13: DCT Definitions

Term	Definition
MRS	JEDEC defined DRAM Mode Register Set.
NP	No DIMM populated
NumDimmSlots	The number of motherboard DIMM slots per channel plus rows of Solder-down DRAM devices
NumRanks	DDR3 SPDByte[7][5:3] of the DIMM being configured, or the number of ranks soldered down.
Rank	The rank being configured
RankMap	DDR3 SPDByte[63][0] of the DIMM being configured.
RowAddrBits	DDR3 SPDByte[5][5:3] of the DIMM being configured.
Solder-down DRAM	DRAM devices soldered directly to the motherboard.
SODIMM	DCT is configured for SODIMM if (D18F2x90_dct[0][UnbuffDimm]==1) and SODIMMs are populated.
SPD	Serial Presence Detect. In the case of DRAMs soldered on the platform, this refers to a virtual representation of the DRAM vendors' data sheets.
SR	Single Rank
UDIMM	DCT is configured for UDIMM if (D18F2x90_dct[0][UnbuffDimm]==1) and UDIMMs are populated.
VDDIO	DDR VDDIO in V.

2.9.2 DCT Frequency Support

The tables below list the maximum DIMM speeds supported by the processor for different configurations. The motherboard should comply with the relevant AMD socket motherboard design guideline (MBDG) to achieve the rated speeds. In cases where MBDG design options exist, lower-quality options may compromise the maximum achievable speed; motherboard designers should assess the tradeoffs.

Table 14: DDR3 [UDIMM](#) Maximum Frequency Support with 6-layer Motherboard Design FT3b

Num-DimmSlots	Dimms Populated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	-
		-	1	1866	1600	-
2	1	1	-	1866	1600	-
		-	1	1866	1600	-
		2	-	1600	1333	-
	2	1	1	1333	1333	-
		-	2	1333	1333	-
		2	-	1333	1333	-

1. Population restrictions (including the order for partially populated channels) may apply.

Table 15: DDR3 SODIMM Maximum Frequency Support with 6-layer Motherboard Design FT3b

Num-DimmS-lots	Dimms Populated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
2	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
	2	2	-	1600	1600	1333
		1	1	1600	1333	1066
		-	2	1600	1333	1066
1. Population restrictions (including the order for partially populated channels) may apply.						
2.						

Table 16: DDR3 UDIMM Maximum Frequency Support with 4-layer Motherboard Design FT3b

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1333	-
		-	1	1866	1333	-
2	1	1	-	1866	1333	-
		-	1	1866	1333	-
	2	2	-	1600	1333	-
		1	1	1333	1333	-
		-	2	1333	1333	-
1. Population restrictions (including the order for partially populated channels) may apply.						
2.						

Table 17: DDR3 SODIMM Maximum Frequency Support with 4-layer Motherboard Design FT3b

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1600	1333	1066
		-	1	1600	1333	1066
2	1	1	-	1333	1333	1066
		-	1	1333	1333	1066
	2	2	-	1333	1333	1066
		1	1	1333	1333	1066
		-	2	1333	1333	1066
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 18: DDR3 SODIMM plus Solder-down DRAM Maximum Frequency with 6-layer Motherboard FT3b

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
2	1	1	-	1333	1333	1066
		-	1	1333	1333	1066
	2	2	-	1333	1333	1066
		1	1	1066	1066	1066
		-	2	1066	1066	1066
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 19: DDR3 SODIMM plus Solder-down DRAM Maximum Frequency with 4-layer Motherboard FT3b

Num-Dimms-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
2	1	1	-	1066	1066	1066
		-	1	1066	1066	1066
	2	2	-	1066	1066	1066
		1	1	1066	1066	1066
		-	2	1066	1066	1066
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 20: DDR3 Solder-down DRAM Maximum Frequency Support FT3b

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 21: DDR3 Solder-down DRAM Maximum Frequency Support with Low Power Motherboard FT3b

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1333	1333	-
		0	1	1333	1333	-
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 22: DDR3 **UDIMM** Maximum Frequency Support with 6-layer Motherboard Design FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	-
		-	1	1866	1600	-
2	1	1	-	1866	1600	-
		-	1	1866	1600	-
	2	2	-	1600	1333	-
		1	1	1333	1333	-
		-	2	1333	1333	-
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 23: DDR3 **SODIMM** Maximum Frequency Support with 6-layer Motherboard Design FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
2	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
	2	2	-	1600	1600	1333
		1	1	1600	1333	1066
		-	2	1600	1333	1066

1. Population restrictions (including the order for partially populated channels) may apply.

2.

Table 24: DDR3 **UDIMM** Maximum Frequency Support with 4-layer Motherboard Design FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1333	-
		-	1	1866	1333	-
2	1	1	-	1866	1333	-
		-	1	1866	1333	-
	2	2	-	1600	1333	-
		1	1	1333	1333	-
		-	2	1333	1333	-
1. Population restrictions (including the order for partially populated channels) may apply.						
2.						

Table 25: DDR3 SODIMM Maximum Frequency Support with 4-layer Motherboard Design FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1600	1333	1066
		-	1	1600	1333	1066
2	1	1	-	1333	1333	1066
		-	1	1333	1333	1066
	2	2	-	1333	1333	1066
		1	1	1333	1333	1066
		-	2	1333	1333	1066

1. Population restrictions (including the order for partially populated channels) may apply.

Table 26: DDR3 SODIMM plus Solder-down DRAM Maximum Frequency with 6-layer Motherboard FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
2	1	1	-	1333	1333	1066
		-	1	1333	1333	1066
	2	2	-	1333	1333	1066
		1	1	1066	1066	1066
		-	2	1066	1066	1066
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 27: DDR3 SODIMM plus Solder-down DRAM Maximum Frequency with 4-layer Motherboard FP4

Num-DimmS-lots	Dimms Popu-lated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
2	1	1	-	1066	1066	1066
		-	1	1066	1066	1066
	2	2	-	1066	1066	1066
		1	1	1066	1066	1066
		-	2	1066	1066	1066
1. Population restrictions (including the order for partially populated channels) may apply.						

Table 28: DDR3 Solder-down DRAM Maximum Frequency Support FP4

Num-DimmSlots	Dimms Populated	DRAM		Frequency ¹ (MT/s)		
		SR	DR	1.5V	1.35V	1.25V
1	1	1	-	1866	1600	1333
		-	1	1866	1600	1333
1. Population restrictions (including the order for partially populated channels) may apply.						

The tables below list the DIMM populations as supported by the processor. DIMMs must be populated from farthest slot to closest slot to the processor on a per channel basis when a daisy chain topology is used.

Table 29: DDR3 Population Support

NumDimmSlots	DIMM0	DIMM1
1	SR/DR	N/A
2	NP	SR/DR
	SR/DR	NP
	SR/DR	SR/DR

2.9.3 DCT Configuration Registers

There are multiple types of DCT configuration registers:

- Registers for which there is one instance. E.g. [D18F2xA4](#) or [D18F2x78_dct\[0\]](#).
- Registers for which there is one instance per NbPstate use [D18F1x10C\[NbPsSel\]](#) for software accesses.
 - [D18F2x210_dct\[0\]_nbp\[3:0\]](#) refers to all instances of the D18F2x210 register.
 - [D18F2x210_dct\[0\]_nbp\[1\]](#) refers to the register for Nb P-state 1 of any or all DCTs.
- Registers for which there is one instance per memory P-state use [D18F1x10C\[MemPsSel\]](#) for software accesses. The syntax for this register type is described by example as follows:
 - [D18F2x2E8_dct\[0\]_mp\[1:0\]](#) refers to all instances of the D18F2x2E8 register.
 - [D18F2x2E8_dct\[0\]_mp\[1\]](#) refers to the register for memory P-state 1 of either or both DCTs.

2.9.4 DDR Pad to Processor Pin Mapping

The relationship of pad drivers to processor pins varies by package as shown in the following table.

Table 30: Package pin mapping

Pad	Pin ¹
	FT3
MEMCLK0_H[0]	MA_CLK_H[0]
MEMCLK0_H[1]	MA_CLK_H[1]
MEMCLK0_H[2]	MA_CLK_H[2]
MEMCLK0_H[3]	MA_CLK_H[3]
MEMCLK0_H[4]	NC

Table 30: Package pin mapping

Pad	Pin ¹
	FT3
MEMCLK0_H[5]	NC
MEMCS0_L[0]	MA0_CS_L[0]
MEMCS0_L[1]	MA0_CS_L[1]
MEMCS0_L[2]	MA1_CS_L[0]
MEMCS0_L[3]	MA1_CS_L[1]
MEMCS0_L[4]	NC
MEMCS0_L[5]	NC
MEMCS0_L[6]	NC
MEMCS0_L[7]	NC
MEMODT0[0]	MA0_ODT[0]
MEMODT0[1]	MA0_ODT[1]
MEMODT0[2]	MA1_ODT[0]
MEMODT0[3]	MA1_ODT[1]
MEMCKE0[0]	MA_CKE[0]
MEMCKE0[1]	MA_CKE[1]
MEMCKE0[2]	MA_CKE[2]
MEMCKE0[3]	MA_CKE[3]
1. For differential pins, only positive polarity pins are shown; negative polarity pins have corresponding mapping and are controlled by the same CSR field. NC = Not connected. BIOS should tri-state or disable the pad for maximum power savings.	

2.9.4.1 DDR Chip to Pad Mapping

The relationship of chip to pad drivers is shown in the following table. BIOS should disable or power down unused chips for maximum power savings.

Table 31: Pad (from chiplet) pin mapping

Chip	Group	Pad ¹
Clk chip 0	0	MEMCLK0_H[1:0]
Clk chip 1	0	MEMCLK0_H[3:2]
Cmd/Addr 0	0	MEMCS0_L[7,5,3,1]
	1	MEMODT0[3:0]
	2	MEMCS0_L[6,4,2,0]

Table 31: Pad (from chiplet) pin mapping

Cmd/Addr 1	0	MEMRAS0_L
		MEMCAS0_L
		MEMWE0_L
		MEMADD0[13]
	1	MEMADD0[10,0]
		MEMBANK0[1:0]
	2	MEMPAR0
Address 2	0	MEMCKE0[3:0]
	1	MEMADD0[0,1,8,9]
	2	MEMADD0[2,3,10,11]
	3	MEMADD0[4,5,12,13]
	4	MEMADD0[6,7,14,15]
Data ²	0	MEMDATA[5,4,1,0]
	1	MEMDQS_H[0], MEMDQSDM[0]
	2	MEMDATA[7,6,3,2]
<p>1. For differential pads, only positive polarity pads are shown; negative polarity pads have corresponding mapping and are controlled by the same chip. Only channel A map is shown. For multi-channel products the other channels are similar.</p> <p>2. Only Data chip 0 is shown. Remaining data chips are repeated with sequential DQ/DQS/DM pin numbers.</p>		

2.9.5 DRAM Controller Direct Response Mode

The DCT supports direct response mode for responding to a cache line fill request before the DCT is initialized. In direct response mode, the target DCT responds to a cache line fill request by returning 64 bytes of all ones without issuing a read transaction on the DRAM bus. The BIOS uses this feature to allocate cache lines for temporary data storage. The controller exits direct response mode when [D18F2x7C_dct\[0\]\[EnDramInit\]](#) is set to 1. See [2.3.3 \[Using L2 Cache as General Storage During Boot\]](#).

2.9.6 DRAM Data Burst Mapping

DRAM requests are mapped to data bursts on the DDR bus in the following order:

- When [D18F2x110\[DctDatIntLv\]](#) = 0, a 64 B request is mapped to each of the eight sequential data beats as QW0, QW1...QW7.
- When [D18F2x110\[DctDatIntLv\]](#) = 1, the order of cache data to QW on the bus is the same except that even and odd bits are interleaved on the DRAM bus as follows:
 - For every 8 bytes in the cache line, even bits map to QW0, QW2, QW4, and QW6 on the DRAM bus.
 - For every 8 bytes in the cache line, odd bits map to QW1, QW3, QW5, and QW7 on the DRAM bus.

2.9.7 DCT/DRAM Initialization and Resume

DRAM initialization involves several steps in order to configure the DRAM controllers and the DRAM, and to tune the DRAM channel for optimal performance.

DRAM resume requires several steps to configure the DCTs to properly resume from the S3 state.

The following sequence describes the steps needed after a reset for initialization or resume:

1. Configure the DDR supply voltage regulator. See 2.9.7.1.
2. Force NB P-state to NBP0.
3. Force register accesses to M0. See 2.9.7.3 for further requirements used in steps below.
4. DDR phy initialization. See 2.9.7.4.
5. DRAM device and controller initialization.
 - If BIOS is booting from an unpowered state (ACPI S4, S5 or G3), then it performs the following:
 - a. Program SPD configuration. See 2.9.7.5.
 - b. Program Non-SPD configuration. See 2.9.7.6.
 - c. Program DCT training specific configuration. See 2.9.7.7.
 - d. Program the remaining DCT registers not covered by an explicit sequence dependency.
 - e. DRAM device initialization. See 2.9.7.8.
 - If BIOS is resuming the platform from S3 state, then it performs the following:
 - a. Restore all DCT and phy registers that were programmed during the first boot from non-volatile storage. See 2.9.7.5 and 2.9.7.6 for a review of registers.
 - b. Program D18F2x90_dct[0][ExitSelfRef] = 1.
 - c. Restore the trained delayed values (found during the initial boot in step 6 below) from nonvolatile storage.
 - d. Continue at step 8.
6. DRAM data training.
 - A. Write levelization training. See 2.9.7.9.1.
 - B. DQS receiver enable training. See 2.9.7.9.2, 2.9.7.9.3, and 2.9.7.9.4.
 - C. DQS position training. See 2.9.7.9.5.
7. NB P-state specific training. For each NB P-state to D18F5x170[NbPstateMaxVal]:
 - A. Force the NB P-state. See 2.9.7.2.
 - B. MaxRdLatency training. See 2.9.7.9.6.1.
8. Release NB P-state force.
9. Program DRAM phy for power savings. See 2.9.7.10.
10. Program DCT for normal operation. See 2.9.7.7.

The DRAM subsystem is ready for use.

2.9.7.1 Low Voltage DDR3

The processor supports JEDEC defined DDR3L and DDR3U devices which operate at voltages lower than 1.5V.

Platforms supporting low voltage devices should power up VDDIO at 1.35V. BIOS should not operate DIMMs at voltages higher than supported as indicated by SPD Byte 6: Module Nominal Voltage, VDD.

BIOS should consult vendor data sheets for the supply voltage regulator programming requirements. On supported platforms, BIOS must take steps to configure the supply voltage regulators as follows:

1. Read the SPD of all DIMMs within the programmable VDDIO domain and check all of the defined bits

- within the SPD byte to determine the common operating voltages.
- 2. Configure VDDIO to match the lowest common supported voltage based on the SPD values.
 - If the DIMMs do not specify a common operating voltage then BIOS must take platform vendor defined action to notify the end user of the mismatch and to protect DIMMs from damage.
- 3. Additional derating of the DDR speed may be necessary for reliable operation at lower voltage. See [2.9.2 \[DCT Frequency Support\]](#).

2.9.7.2 NB P-state Specific Configuration

A subset of DCT configuration and training must be repeated for each enabled NB P-state. To accomplish this, BIOS forces the processor to the desired NB P-state and releases the force once DRAM initialization and training is complete. See [2.5.4.1 \[NB P-states\]](#) and [2.5.4.1.2.2 \[NB P-state Transitions\]](#).

2.9.7.3 Memory P-state Specific Configuration

A subset of DCT configuration and training must be repeated for each enabled memory P-state. See also [2.5.7.1 \[Memory P-states\]](#).

To accomplish this, BIOS forces the processor to the NBP0 state and uses the M0 context to train for values that are used by all memory P-states. For example, BIOS uses [D18F2x94_dct\[0\]\[MemClkFreq\]](#) to specify the dram frequency during each pass of training. BIOS saves the trained configuration values at each step and uses them appropriately as outlined below:

1. Force NB P-state to NBP0. See [2.9.7.2](#).
2. Program [D18F1x10C\[MemPsSel\]](#)=0. See [2.9.3](#).
3. Program [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#)=0.
4. Using the M0 context, BIOS optimally configures the controller and trains at DDR667 according to [2.9.7](#) steps 4 thru 7.
 - A. BIOS saves the trained values for use in M1 and for subsequent higher frequencies.
 - B. BIOS saves the controller configuration for use in M1.
 - C. BIOS optimally writes all the values to registers in step 6. It may optionally write the values as each is computed or trained. If this is done then BIOS must ensure that [D18F1x10C\[MemPsSel\]](#) and [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#) are configured correctly before and after each register access.
5. BIOS increases the frequency and repeats step 4 until the target frequency is trained. The target frequency is always associated with M0.
6. BIOS programs the M1 controller context with the DDR667 configuration and trained results. This must be done before the next subsequent NB P-state change.
 - a. Program [D18F1x10C\[MemPsSel\]](#)=1.
 - b. Program [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#) = 1.
 - c. Program [D18F2x2E0_dct\[0\]\[M1MemClkFreq\]](#) and [D18F2x9C_x0D0F_E000_dct\[0\]_mp\[1\]\[Rate, FreqValid\]](#) = {04h, 1}.
 - d. Program DCT configuration and trained delay values saved earlier.

Three groups of registers must be written in the same order as the initialization sequence:

 - Fence values: [D18F2x9C_x0000_000C_dct\[0\]](#), [D18F2x9C_x0D0F_0\[F,8:0\]31_dct\[0\]](#), [D18F2x9C_x0D0F_E019_dct\[0\]](#).
 - Address/Command timing delays: [D18F2x9C_x0000_0004_dct\[0\]_mp\[1:0\]](#).
 - All other Data/Dqs delays: See step 6 in section [2.9.7](#).
 - e. Program [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#) = 0.
 - f. Program [D18F1x10C\[MemPsSel\]](#) = 0.

2.9.7.4 DDR Phy Initialization

The BIOS initializes the phy and the internal interface from the DCT to the phy, including the PLLs and the fence value, after each reset and for each time a MEMCLK frequency change is made.

BIOS obtains size, loading, and frequency information about the DIMMs and channels using SPDs prior to phy initialization. BIOS then performs the following actions:

1. Program `D18F2x9C_x0D0F_E013_dct[0] = 0118h`.
2. For each byte lane and each memory P-state: Program `D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0][RxSsbMntClkEn] = 0`.
3. IF (`DdrRate` >= 1866) `D18F2x9C_x0D0F_0[F,8:0]38_dct[0][ReducedLoop] = 10b ENDIF`.
4. If (`DllPDBypassMode`) then
Program `D18F2x9C_x0D0F_[C,8,2][2:0]1E_dct[0]_mp[1:0][DllPDBypass] = 1`.
5. `D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0][LowPowerRcvrEn] = ((Solder-down DRAM && DdrRate <= 1333) || DdrRate == 667)`.
6. Program `D18F2xA8_dct[0][MemPhyPllPdMode] = 00b`.
7. Force the phy to M0 with the following sequence.
 - A. Program `D18F2x9C_x0D0F_E006_dct[0][PllLockTime] = 190h`.
 - B. Program `D18F2x9C_x0000_000B_dct[0] = 80800000h`.
 - C. Program `D18F2x9C_x0000_000D18F2x9C_x0000_000B_dct[0] = 40000000h`.
 - D. For each DCT: Program `D18F2x9C_x0000_000B_dct[0] = 80000000h`.
 - E. Program `D18F2x94_dct[0][MemClkFreq] = 200 MHz`.
 - F. Program `D18F2x94_dct[0][MemClkFreqVal] = 1`. Wait for `D18F2x94_dct[0][FreqChgInProg] = 0`.
8. Phy Voltage Level Programming. See 2.9.7.4.1.
9. DRAM channel frequency change. See 2.9.7.4.2.
10. Phy fence programming. See 2.9.7.4.3.
11. Phy compensation initialization. See 2.9.7.4.4.

2.9.7.4.1 Phy Voltage Level Programming

BIOS programs the following according to the desired phy VDDIO voltage level:

- Program `D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0][RxVioLvl]`.
 - Program `D18F2x9C_x0D0F_[C,8,2][2:0]1F_dct[0][RxVioLvl]`.
 - Program `D18F2x9C_x0D0F_4009_dct[0][CmpVioLvl,ComparatorAdjust]`.
 - Program `D18F2x9C_x0D0F_4006_dct[0][VrefSel] = 0`.
 - Program `D18F2x9C_x0D0F_4007_dct[0]` per platform requirements.
- See 2.9.7.1 [Low Voltage DDR3].

2.9.7.4.2 DRAM Channel Frequency Change

The following sequence is used to change the DRAM frequency under all boot conditions, including restoring the DCT state when resuming from the S3 state. BIOS performs the sequence only on DCTs with an enabled interface (`D18F2x94_dct[0][DisDramInterface] == 0`):

For each DCT:

1. Program `D18F2x9C_x0D0F_E006_dct[0][PllLockTime] = 190h`.
2. Program `D18F2x94_dct[0][MemClkFreqVal] = 0`.
3. Program `D18F2x94_dct[0][MemClkFreq]` to the desired DRAM frequency.
4. Program the following parameters which must be configured prior to setting `MemClkFreqVal`:
 - `D18F2x94_dct[0][ProcOdtDis]`
 - `D18F2x9C_x0000_0004_dct[0]_mp[1:0]`

- [D18F2x9C_x0D0F_0\[F,8:0\]13_dct\[0\]_mp\[1:0\]\[ProcOdtAdv\]](#)
- [D18F2x210_dct\[0\]_nbp\[3:0\]\[RdPtrInit, DataTxFifoWrDly\]](#) of the current NB P-state for the target MEMCLK frequency. See also [2.9.7.2](#).

For each DCT:

5. Program [D18F2x94_dct\[0\]\[MemClkFreqVal\]](#) = 1. Wait for [D18F2x94_dct\[0\]\[FreqChgInProg\]](#) = 0.

For each DCT:

6. Program [D18F2x9C_x0D0F_E006_dct\[0\]\[PllLockTime\]](#) according to [Table 32](#).

BIOS must observe the following requirements:

- BIOS must not change the PLL frequency after DRAM has exited from self-refresh.
- BIOS must not change the PLL frequency after the DRAM training for DDR3 DIMMs is complete.

Table 32: DDR PLL Lock Time

D18F2xA8_dct[0][MemPhyPllPdMode]	PllLockTime
00b	0Fh
10b	190h

2.9.7.4.2.1 Requirements for DRAM Frequency Change During Training

During DRAM training, BIOS may be required to change the DRAM(MEMCLK) frequency. The steps below describe what is required to prepare the processor and memory subsystem for the new MEMCLK frequency. It is assumed that the memory subsystem has previously been initialized at the current MEMCLK frequency, and this procedure describes only the steps that must be repeated at the new MEMCLK frequency. See [2.9.7.9.1 \[Write Levelization Training\]](#) and [2.9.7.9.2 \[DQS Receiver Enable Training\]](#).

1. Force the NB P-state. See [2.9.7.2](#).
2. Enter self-refresh:
 - A. Program [D18F2x90_dct\[0\]\[DisDllShutdownSR\]](#) = 1.
 - B. Program [D18F2x90_dct\[0\]\[EnterSelfRef\]](#) = 1.
 - C. Wait for [D18F2x90_dct\[0\]\[EnterSelfRef\]](#) = 0.
3. If ([DllPDBypassMode](#)) [D18F2x9C_x0D0F_0\[F,8:0\]1E_dct\[0\]_mp\[1:0\]\[DllPDBypass\]](#) = 0.
4. DRAM channel frequency change. See [2.9.7.4.2](#).
5. Change NCLK frequency to meet NCLK-MEMCLK ratio requirements. See [2.5.3.1.5](#).
6. Phy fence programming. See [2.9.7.4.3](#).
7. Phy compensation initialization. See [2.9.7.4.4](#).
8. Program SPD configuration. See [2.9.7.5](#).
9. Program Non-SPD configuration. See [2.9.7.6](#).
10. Exit self-refresh:
 - A. Program [D18F2x90_dct\[0\]\[ExitSelfRef\]](#) = 1.
 - B. Wait for [D18F2x90_dct\[0\]\[ExitSelfRef\]](#) = 0.
 - C. Program [D18F2x90_dct\[0\]\[DisDllShutdownSR\]](#) = 0.
11. Re-program devices with frequency dependent mode register field values. See [2.9.7.8](#).

2.9.7.4.3 Phy Fence Programming

The DDR phy fence logic is used to adjust the phase relationship between the data fifo and the data going to the pad. After any MEMCLK frequency change and before any memory training, BIOS must perform phy fence training for each channel using the following steps:

1. Program `D18F2x9C_x0D0F_0[F,8:0]31_dct[0]` = 0000_0000h.
2. Program `D18F2x9C_x0D0F_E019_dct[0]` = 0000_0000h.
3. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][FenceTrSel]`=10b.
4. Program `D18F2x9C_x0000_00[52:50]_dct[0]`=1313_1313h.
5. Perform phy fence training. See 2.9.7.4.3.1 [Phy Fence Training].
6. Write the calculated fence value to `D18F2x9C_x0000_000C_dct[0][FenceThresholdTxDll]`.
7. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][FenceTrSel]`=01b.
8. Program `D18F2x9C_x0000_00[52:50]_dct[0]`=1313_1313h.
9. Perform phy fence training. See 2.9.7.4.3.1 [Phy Fence Training].
10. Write the calculated fence value to `D18F2x9C_x0000_000C_dct[0][FenceThresholdRxDll]`.
11. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][FenceTrSel]`=11b.
12. Program `D18F2x9C_x0000_00[52:50]_dct[0]`=1313_1313h.
13. Perform phy fence training. See 2.9.7.4.3.1 [Phy Fence Training].
14. Write the calculated fence value to `D18F2x9C_x0000_000C_dct[0][FenceThresholdTxPad]`.
15. Program Fence2 threshold for data as follows:
 - A. IF (`D18F2x9C_x0000_000C_dct[0][FenceThresholdTxPad]` < 16) THEN
 Fence2_TxPad[4:0] = { 1b, `D18F2x9C_x0000_000C_dct[0][19:16]` }
 ELSE
 Fence2_TxPad[4:0] = 00000b
 ENDIF.
 - B. IF (`D18F2x9C_x0000_000C_dct[0][FenceThresholdRxDll]` < 16) THEN
 Fence2_RxDll[4:0] = { 1b, `D18F2x9C_x0000_000C_dct[0][24:21]` }
 ELSE
 Fence2_RxDll[4:0] = 00000b
 ENDIF.
 - C. IF (`D18F2x9C_x0000_000C_dct[0][FenceThresholdTxDll]` < 16) THEN
 Fence2_TxDll[4:0] = { 1b, `D18F2x9C_x0000_000C_dct[0][29:26]` }
 ELSE
 Fence2_TxDll[4:0] = 00000b
 ENDIF.
 - D. Program `D18F2x9C_x0D0F_0[F,8:0]31_dct[0]` = {000000b, Fence2_TxDll[4:0], Fence2_TxPad[4:0]}.
 - E. Program `D18F2x9C_x0D0F_E019_dct[0]` = {0b, Fence2_RxDll[4:0], 00000b, Fence2_TxPad[4:0]}.
16. Reprogram `D18F2x9C_x0000_0004_dct[0]_mp[1:0]`.

When resuming from S3, BIOS reprograms `D18F2x9C_x0000_000C_dct[0][FenceThresholdTxDll]`, `FenceThresholdRxDll`, `FenceThresholdTxPad`], and `D18F2x9C_x0D0F_E019_dct[0]` from values stored in non-volatile storage instead of training. BIOS reprograms `D18F2x9C_x0D0F_0[F,8:0]31_dct[0]` and `D18F2x9C_x0D0F_E019_dct[0]` as indicated in the steps above.

BIOS may use `D18F2x9C_x0000_000C_dct[0]` and `D18F2x9C_x0D0F_E01A_dct[0]` for local storage of fence values during the intermediate time between training and writing the values into non-volatile storage in preparation for S3.

2.9.7.4.3.1 Phy Fence Training

1. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][PhyFenceTrEn]`=1.
2. Wait 2000 MEMCLKs.
3. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][PhyFenceTrEn]`=0.
4. Read the phase recovery engine registers `D18F2x9C_x0000_00[52:50]_dct[0]`.
5. Calculate the average of the fine delay values of all byte lanes. If FenceTrSel != 00b subtract 8. If the result

is negative then the fence value is zero.

2.9.7.4.4 Phy Compensation Initialization

Each DDR IO driver has a programmable slew rate controlled by the pre-driver calibration code. The recommended slew rate is a function of the DC drive strength. BIOS initializes the recommended nominal slew rate values as follows:

1. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][DisAutoComp] = 1`.
2. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][DisablePredriverCal]=1`.
3. Program TxPreP/TxPreN for Data and DQS according to [Table 33](#), [Table 34](#), or [Table 35](#).
 - A. Program `D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0]={0000b, TxPreP, TxPreN}`.
 - B. Program `D18F2x9C_x0D0F_0[F,8:0]02_dct[0]={1000b, TxPreP, TxPreN}`.
4. Program TxPreP/TxPreN for Cmd/Addr according to [Table 36](#), [Table 37](#), or [Table 38](#).
 - A. Program `D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0]={0000b, TxPreP, TxPreN}`.
 - B. Program `D18F2x9C_x0D0F_[C,8][1:0]02_dct[0]={1000b, TxPreP, TxPreN}`.
5. Program TxPreP/TxPreN for Clock according to [Table 39](#), [Table 40](#), or [Table 41](#).
 - A. Program `D18F2x9C_x0D0F_2[2:0]02_dct[0]={1000b, TxPreP, TxPreN}`.
6. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][DisAutoComp] = 0`.

Table 33: Phy predriver calibration codes for Data/DQS at 1.5V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	000b	FFFh
	001b	410h
	010b	208h
	011b	104h
1. IF (D18F2x9C_x0D0F_0[F,8:0]06) THEN See <code>D18F2x9C_x0000_0000_dct[0]_mp[1:0][DqsDrvStren]</code> ELSE See <code>D18F2x9C_x0000_0000_dct[0]_mp[1:0][DataDrvStren]</code> ENDIF. 2. See <code>D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0]</code> and <code>D18F2x9C_x0D0F_0[F,8:0]02_dct[0]</code> .		

Table 34: Phy predriver calibration codes for Data/DQS at 1.35V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	000b	FFFh
	001b	FFFh
	010b	820h
	011b	410h
1. IF (D18F2x9C_x0D0F_0[F,8:0]06) THEN See <code>D18F2x9C_x0000_0000_dct[0]_mp[1:0][DqsDrvStren]</code> ELSE See <code>D18F2x9C_x0000_0000_dct[0]_mp[1:0][DataDrvStren]</code> ENDIF. 2. See <code>D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0]</code> and <code>D18F2x9C_x0D0F_0[F,8:0]02_dct[0]</code> .		

Table 35: Phy Predriver Calibration Codes for Data/DQS at 1.25V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	000b	FFFh
	001b	FFFh
	010b	FFFh
	011b	FFFh
<p>1. IF (D18F2x9C_x0D0F_0[F,8:0]06) THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][DqsDrvStren] ELSE See D18F2x9C_x0000_0000_dct[0]_mp[1:0][DataDrvStren] ENDIF.</p> <p>2. See D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0] and D18F2x9C_x0D0F_0[F,8:0]02_dct[0].</p>		

Table 36: Phy predriver calibration codes for Cmd/Addr at 1.5V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	101b	0C3h
	000b	082h
	001b	041h
	010b	041h
	011b	041h
<p>1. IF (D18F2x9C_x0D0F_C002) THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CkeDrvStren] ELSEIF (D18F2x9C_x0D0F_800[A,6,2]) THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CsOdtDrvStren] ELSE See D18F2x9C_x0000_0000_dct[0]_mp[1:0][AddrCmdDrvStren] ENDIF.</p> <p>2. See D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0] and D18F2x9C_x0D0F_[C,8][1:0]02_dct[0].</p>		

Table 37: Phy predriver calibration codes for Cmd/Addr at 1.35V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	101b	208h
	000b	186h
	001b	104h
	010b	0C3h
	011b	082h
<p>1. IF (D18F2x9C_x0D0F_C002)THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CkeDrvStren] ELSEIF (D18F2x9C_x0D0F_800[A,6,2])THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CsOdtDrvStren] ELSE See D18F2x9C_x0000_0000_dct[0]_mp[1:0][AddrCmdDrvStren] ENDIF.</p> <p>2. See D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0] and D18F2x9C_x0D0F_[C,8][1:0]02_dct[0].</p>		

Table 38: Phy Predriver Calibration Codes for Cmd/Addr at 1.25V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667- 2133	101b	410h
	000b	30Ch
	001b	28Ah
	010b	208h
	011b	186h
<p>1. IF (D18F2x9C_x0D0F_C002)THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CkeDrvStren] ELSEIF (D18F2x9C_x0D0F_800[A,6,2])THEN See D18F2x9C_x0000_0000_dct[0]_mp[1:0][CsOdtDrvStren] ELSE See D18F2x9C_x0000_0000_dct[0]_mp[1:0][AddrCmdDrvStren] ENDIF.</p> <p>2. See D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0] and D18F2x9C_x0D0F_[C,8][1:0]02_dct[0].</p>		

Table 39: Phy predriver calibration codes for Clock at 1.5V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	101b	FFFh
	000b	FFFh
	001b	FFFh
	010b	FFFh
	011b	820h
<p>1. See D18F2x9C_x0000_0000_dct[0]_mp[1:0][ClkDrvStren].</p> <p>2. See D18F2x9C_x0D0F_2[2:0]02_dct[0].</p>		

Table 40: Phy predriver calibration codes for Clock at 1.35V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	101b	FFFh
	000b	FFFh
	001b	FFFh
	010b	FFFh
	011b	FFFh
1. See D18F2x9C_x0000_0000_dct[0]_mp[1:0][ClkDrvStren] . 2. See D18F2x9C_x0D0F_2[2:0]02_dct[0] .		

Table 41: Phy Predriver Calibration Codes for Clock at 1.25V

DDR Rate	Drive Strength ¹	{TxPreP, TxPreN} ²
667 - 2133	101b	FFFh
	000b	FFFh
	001b	FFFh
	010b	FFFh
	011b	FFFh
1. See D18F2x9C_x0000_0000_dct[0]_mp[1:0][ClkDrvStren] . 2. See D18F2x9C_x0D0F_2[2:0]02_dct[0] .		

2.9.7.5 SPD ROM-Based Configuration

The Serial Presence Detect (SPD) ROM is a non-volatile memory device on the DIMM encoded by the DIMM manufacturer. The description of the SPD is usually provided on a data sheet for the DIMM itself along with data describing the memory devices used. The data describes configuration and speed characteristics of the DIMM and the SDRAM components mounted on the DIMM. The associated data sheet also contains the DIMM byte values that are encoded in the SPD on the DIMM.

BIOS reads the values encoded in the SPD ROM through a system-specific interface. BIOS acquires DIMM configuration information, such as the amount of memory on each DIMM, from the SPD ROM on each DIMM and uses this information to program the DRAM controller registers.

For solder-down DRAM, in the absence of an SPD ROM, BIOS provides the information necessary for DRAM configuration. For convenience, this document may refer to solder-down DRAM as a DIMM, and to DRAM data sheet or JEDEC DRAM specifications as SPD ROM based, unless otherwise noted.

The SPD ROM provides values for several DRAM timing parameters that are required by the DCT. In general, BIOS should use the optimal value specified by the SPD ROM. These parameters are:

- [D18F2x8C_dct\[0\]\[Tref\]](#)
- [D18F2x200_dct\[0\]_mp\[1:0\]\[Tras\]](#): Active to precharge time
- [D18F2x200_dct\[0\]_mp\[1:0\]\[Trp\]](#): Precharge time
- [D18F2x200_dct\[0\]_mp\[1:0\]\[Trcd\]](#): RAS to CAS delay
- [D18F2x200_dct\[0\]_mp\[1:0\]\[Tcl\]](#): CAS latency
- [D18F2x204_dct\[0\]_mp\[1:0\]\[Trtp\]](#): Internal read to precharge command delay time

- [D18F2x204_dct\[0\]_mp\[1:0\]\[FourActWindow\]](#): Four activate window delay time
- [D18F2x204_dct\[0\]_mp\[1:0\]\[Trrd\]](#): Row active to row active delay
- [D18F2x204_dct\[0\]_mp\[1:0\]\[Trc\]](#): Active to active/refresh time
- [D18F2x208_dct\[0\]\[Trfc3, Trfc2, Trfc1, Trfc0\]](#): Refresh recovery delay time
- [D18F2x20C_dct\[0\]_mp\[1:0\]\[Twtr\]](#): Internal write to read command delay time
- [D18F2x22C_dct\[0\]_mp\[1:0\]\[Twr\]](#): Write recovery time

Optimal cycle time is specified for each DIMM and is used to limit or determine bus frequency. See [2.9.7.8 \[DRAM Device and Controller Initialization\]](#).

The DRAM data sheet or the JEDEC DRAM specification provides values for some DRAM timing parameters that are required by the DCT, regardless of whether the DRAMs are solder-down. Most of these parameters have a fixed time component as part of their specification. If memory P-states are supported (See [2.5.7.1 \[Memory P-states\]](#)) and a timing register does not have per memory P-state contexts, BIOS must evaluate the minimum value for each frequency and choose the most pessimistic value for all frequencies to program into the register. These parameters are:

- [D18F2x20C_dct\[0\]_mp\[1:0\]\[Tcwl\]](#): CAS write latency
- [D18F2x220_dct\[0\]\[Tmrd\]](#): MRS command cycle time
- [D18F2x220_dct\[0\]\[Tmod\]](#): MRS command recovery time
- [D18F2x224_dct\[0\]\[Tzqcs\]](#): Short calibration command recovery time
- [D18F2x224_dct\[0\]\[Tzqoper\]](#): Long calibration command recovery time
- [D18F2x248_dct\[0\]_mp\[1:0\]\[Txpdll\]](#): Exit precharge power down (with DLL frozen) to command delay.
- [D18F2x248_dct\[0\]_mp\[1:0\]\[Txp\]](#): Exit precharge power down to command delay.
- [D18F2x24C_dct\[0\]\[Tcksrx\]](#): Clock stable to self refresh exit delay
- [D18F2x24C_dct\[0\]\[Tcksre\]](#): Self refresh entry to clock removal delay
- [D18F2x24C_dct\[0\]\[Tckesr\]](#): Self refresh entry to command delay
- [D18F2x24C_dct\[0\]\[Tpd\]](#): Power down entry to exit delay. BIOS may increase this value above the JEDEC minimum for certain power down modes.

2.9.7.6 Non-SPD ROM-Based Configuration

There are several DRAM timing parameters and DCT configurations that need to be programmed for optimal memory performance. These values are not derived from the SPD ROM. Several of these timing parameters are functions of other configuration values. These interdependencies must be considered when programming values into several DCT register timing fields. The factors to consider when specifying a value for a specific non-SPD timing parameter are:

- Training delay values. See [2.9.7.9 \[DRAM Training\]](#).
- Read and write latency differences.
- The phy's idle clock requirements on the data bus.
- DDR3 ODT timing requirements.
- NCLK frequency
- MEMCLK frequency

The following sub-sections describe how BIOS programs each non-SPD related timing field to a recommended minimum timing value with respect to the above factors.

The following terms are defined to simplify calculations and are calculated in MEMCLKs:

- Latency Difference (LD) = [D18F2x200_dct\[0\]_mp\[1:0\]\[Tcl\]](#) - [D18F2x20C_dct\[0\]_mp\[1:0\]\[Tcwl\]](#).
- Read ODT Delay (ROD) = MAX(0, [D18F2x240_dct\[0\]_mp\[1:0\]\[RdOdtOnDuration\]](#) - 6).
- Write ODT Delay (WOD) = MAX(0, [D18F2x240_dct\[0\]_mp\[1:0\]\[WrOdtOnDuration\]](#) - 6).

- $WrEarly = ABS(D18F2x20C_dct[0_mp[1:0][WrDqDqsEarly]) / 2$

2.9.7.6.1 TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Read to Read Timing)

The optimal values for `D18F2x218_dct[0_mp[1:0][TrdrdSdSc, TrdrdSdDc, TrdrdDd]` are platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program these parameters to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- $TrdrdSdSc$ (in MEMCLKs) = 1.
- $TrdrdSdDc$ (in MEMCLKs) = $MAX(TrdrdSdSc, 3 + (IF (D18F2xA8_dct[0][PerRankTimingEn]) THEN CEIL(CDD_{TrdrdSdDc} / 2 + 0.5) ELSE 0 ENDIF))$.
- $TrdrdDd$ (in MEMCLKs) = $MAX(TrdrdSdDc, ROD + 3, CEIL(CDD_{TrdrdDd} / 2 + 3.5))$.

The Critical Delay Difference (CDD) is the largest delay difference of the channel.

- Each delay difference is `D18F2x9C_x0000_00[2A:10]_dct[0_mp[1:0][DqsRcvEnGrossDelay]` minus `D18F2x9C_x0000_00[2A:10]_dct[0_mp[1:0][DqsRcvEnGrossDelay]`.
- For $CDD_{TrdrdSdDc}$, the subtraction terms are the delays of different chip selects within the same DIMM within the same byte lane.
- For $CDD_{TrdrdDd}$, the subtraction terms are the delays of different DIMMs within the same byte lane.

2.9.7.6.2 TwrwrSdSc, TwrwrSdDc, TwrwrDd (Write to Write Timing)

The optimal values for `D18F2x214_dct[0_mp[1:0][TwrwrSdSc, TwrwrSdDc, TwrwrDd]` are platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program these parameters to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- $TwrwrSdSc$ (in MEMCLKs) = 1.
- $TwrwrSdDc$ (in MEMCLKs) = $MAX(TwrwrSdSc, WOD + 3, 3 + (IF (D18F2xA8_dct[0][PerRankTimingEn]) THEN CEIL(CDD_{TwrwrSdDc} / 2 + 0.5) ELSE 0 ENDIF))$.
- $TwrwrDd$ (in MEMCLKs) = $MAX(TwrwrSdDc, WOD + 3, CEIL(CDD_{TwrwrDd} / 2 + 3.5))$.

The Critical Delay Difference (CDD) is the largest delay difference of the channel.

- Each delay difference is `D18F2x9C_x0000_00[4A:30]_dct[0_mp[1:0][WrDqsGrossDly]` minus `D18F2x9C_x0000_00[4A:30]_dct[0_mp[1:0][WrDqsGrossDly]`.
- For $CDD_{TwrwrSdDc}$, the subtraction terms are the delays of different chip selects within the same DIMM within the same byte lane.
- For $CDD_{TwrwrDd}$, the subtraction terms are the delays of different DIMMs within the same byte lane.

2.9.7.6.3 Twrrd (Write to Read DIMM Termination Turn-around)

The optimal value for `D18F2x218_dct[0_mp[1:0][Twrrd]` is platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program these parameters to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- $Twrrd$ (in MEMCLKs) = $MAX(1, MAX(WOD, CEIL(CDD_{Twrrd} / 2 + 2 - WrEarly)) - LD + 3)$.

The Critical Delay Difference (CDD) is the largest delay difference of the channel.

- Each delay difference is `D18F2x9C_x0000_00[4A:30]_dct[0_mp[1:0][WrDqsGrossDly]` minus `D18F2x9C_x0000_00[2A:10]_dct[0_mp[1:0][DqsRcvEnGrossDelay]`.

- For CDD_{TrwtTO} , the subtraction terms are the delays of different chip selects within the same byte lane.

2.9.7.6.4 TrwtTO (Read-to-Write Turnaround for Data, DQS Contention)

The optimal value for [D18F2x21C_dct\[0\]_mp\[1:0\]](#)[TrwtTO] is platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program this parameter to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values after DDR training is complete:

- $TrwtTO$ (in MEMCLKs) = $MAX(ROD, CEIL(CDD_{TrwtTO} / 2 + WrEarly)) + LD + 3$.
- If 1 DIMM/ch, substitute $ROD = 0$ in the above equation.

The Critical Delay Difference (CDD) is the largest delay difference of the channel.

- Each delay difference is [D18F2x9C_x0000_00\[2A:10\]_dct\[0\]_mp\[1:0\]](#)[DqsRcvEnGrossDelay] minus [D18F2x9C_x0000_00\[4A:30\]_dct\[0\]_mp\[1:0\]](#)[WrDqsGrossDly].
- For CDD_{TrwtTO} , the subtraction terms are the delays of all chip selects within the same byte lane.

2.9.7.6.5 DRAM ODT Control

BIOS configures the DIMM ODT behavior per chip select according to the DIMM population. The ODT pin patterns for reads and writes are programmed using [D18F2x\[234:230\]_dct\[0\]](#) and [D18F2x\[23C:238\]_dct\[0\]](#), respectively.

BIOS also configures the ODT pin pattern used during write leveling by programming [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]](#)[WrLvOdtEn, WrLvOdt]. BIOS programs WrLvOdt with the [D18F2x\[23C:238\]_dct\[0\]](#) value provided for writes to the rank targeted by training. See 2.9.7.9.1 [Write Levelization Training].

Table 42: DDR3 ODT Pattern [NumDimmSlots=1](#)

DIMM0 ¹	D18F2x[234:230]_dct[0]		D18F2x[23C:238]_dct[0]	
	D18F2x234	D18F2x230	D18F2x23C	D18F2x238
SR	0000_0000h	0000_0000h	0000_0000h	0000_0001h
DR	0000_0000h	0000_0000h	0000_0000h	0000_0201h

1. DIMM0: MEMCSx[1:0], MEMODTx[1,0].

Table 43: DDR3 ODT Pattern [NumDimmSlots=2](#)

DIMM0 ¹	DIMM1 ¹	D18F2x[234:230]_dct[0]		D18F2x[23C:238]_dct[0]	
		D18F2x234	D18F2x230	D18F2x23C	D18F2x238
-	SR	0000_0000h	0000_0000h	0000_0000h	0004_0000h
-	DR	0000_0000h	0000_0000h	0000_0000h	0804_0000h
SR	-	0000_0000h	0000_0000h	0000_0000h	0000_0001h
DR	-	0000_0000h	0000_0000h	0000_0000h	0000_0201h
SR/DR	SR/DR	0000_0000h	0101_0404h	0000_0000h	0905_0605h

1. DIMM0: MEMCSx[1:0], MEMODTx[1,0].

DIMM1: MEMCSx[3:2], MEMODTx[3,2].

Table 44: DDR3 ODT Pattern [NumDimmSlots=1](#) FP4

DIMM0 ¹	D18F2x[234:230]_dct[0]		D18F2x[23C:238]_dct[0]	
	D18F2x234	D18F2x230	D18F2x23C	D18F2x238
SR	0000_0000h	0000_0000h	0000_0000h	0000_0001h
DR	0000_0000h	0000_0000h	0000_0000h	0000_0401h
1. DIMM0: MEMCSx[1:0], MEMODTx[2,0].				

Table 45: DDR3 ODT Pattern [NumDimmSlots=2](#) FP4

DIMM0 ¹	DIMM1 ¹	D18F2x[234:230]_dct[0]		D18F2x[23C:238]_dct[0]	
		D18F2x234	D18F2x230	D18F2x23C	D18F2x238
-	SR	0000_0000h	0000_0000h	0000_0000h	0002_0000h
-	DR	0000_0000h	0000_0000h	0000_0000h	0802_0000h
SR	-	0000_0000h	0000_0000h	0000_0000h	0000_0001h
DR	-	0000_0000h	0000_0000h	0000_0000h	0000_0401h
SR/DR	SR/DR	0000_0000h	0101_0202h	0000_0000h	0903_0603h
1. DIMM0: MEMCSx[1:0], MEMODTx[2,0]. DIMM1: MEMCSx[3:2], MEMODTx[3,1].					

2.9.7.6.5.1 DRAM ODT Configuration

These tables document the optimal settings for motherboards which meet the relevant AMD motherboard design guidelines. See [2.9.2 \[DCT Frequency Support\]](#) for an overview of the DIMM population and memory bus speed support.

Table 46: BIOS recommendations for MR1[RttNom] and MR2[RttWr] [UDIMM](#)

Condition					MR1	MR2
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	RttNom	RttWr
1	667, 800, 1066	1.5	SR, DR	-	010b	00b
1	1333, 1600, 1866	1.5	SR, DR	-	001b	00b
2	667, 800, 1066	1.5	NP	SR, DR	010b	00b
2	667, 800	1.5	SR, DR	SR, DR	011b	10b
2	1066, 1333	1.5	SR, DR	SR, DR	101b	10b
2	1333, 1600, 1866	1.5	NP	SR, DR	001b	00b
2	1600	1.5	SR, DR	SR, DR	100b	01b

Table 47: BIOS recommendations for MR1[RttNom] and MR2[RttWr] **SODIMM**

Condition					MR1	MR2
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	RttNom	RttWr
1	667, 800, 1066	1.5, 1.35, 1.25	SR, DR	-	010b	00b
1	1333	1.5, 1.35, 1.25	SR, DR	-	001b	00b
1	1600	1.5, 1.35	SR, DR	-	001b	00b
1	1866	1.5	SR, DR	-	001b	00b
2	667, 800, 1066	1.5, 1.35, 1.25	NP	SR, DR	010b	00b
2	667, 800	1.5, 1.35, 1.25	SR, DR	SR, DR	011b	10b
2	1066	1.5, 1.35, 1.25	SR, DR	SR, DR	101b	10b
2	1333	1.5, 1.35, 1.25	NP	SR, DR	001b	00b
2	1333	1.5, 1.35	SR, DR	SR, DR	101b	10b
2	1333	1.25	SR	SR	101b	10b
2	1600	1.5, 1.35	NP	SR, DR	001b	00b
2	1600	1.5	SR, DR	SR, DR	100b	01b
2	1600	1.35	SR	SR	100b	01b
2	1866	1.5	NP	SR, DR	001b	00b

Table 48: BIOS recommendations for MR1[RttNom] and MR2[RttWr] **SODIMM** plus **Solder-down DRAM**

Condition					MR1	MR2
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	RttNom	RttWr
2	667, 800, 1066	1.5, 1.35, 1.25	NP	SR, DR	010b	00b
2	667, 800	1.5, 1.35, 1.25	SR, DR	SR, DR	011b	10b
2	1066	1.5, 1.35, 1.25	SR, DR	SR, DR	101b	10b
2	1333	1.5, 1.35	NP	SR, DR	001b	00b
2	1333	1.5	SR, DR	SR, DR	101b	10b
2	1333	1.35	SR	SR	101b	10b

Table 49: BIOS recommendations for MR1[RttNom] and MR2[RttWr] [Solder-down DRAM](#)

Condition				MR1	MR2
NumDimmSlots	DdrRate	VDDIO	DIMM0	RttNom	RttWr
1	667	1.5, 1.35, 1.25	SR, DR	000b	00b
1	800, 1066	1.5, 1.35, 1.25	SR, DR	010b	00b
1	1333	1.5, 1.35, 1.25	SR, DR	001b	00b
1	1600	1.5, 1.35	SR, DR	001b	00b
1	1866	1.5	SR, DR	001b	00b

Table 50: BIOS recommendations for MR1[RttNom] and MR2[RttWr] [Solder-down DRAM](#) Low Power Motherboard

Condition				MR1[]	MR2[]
NumDimmSlots	DdrRate	VDDIO	DIMM0	RttNom	RttWr
1	667, 800, 1066, 1333	1.5, 1.35	SR, DR	000b	00b

2.9.7.6.6 DRAM Address Timing and Output Driver Compensation Control

This section describes the settings required for programming the timing on the address pins, the CS/ODT pins, and the CKE pins. The following tables document the address timing and output driver settings on a per channel basis for DDR3. These tables document the optimal settings for motherboards which meet the relevant motherboard design guidelines. See [2.9.2 \[DCT Frequency Support\]](#) for an overview of the DIMM and memory bus speed support.

When POdtOff=0, in all cases the processor ODT is off for writes and is on for reads.

Table 51: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **UDIMM**

Condition					D18F2x9C_x0D0F_0[F:8:0]04_dct[0]_mp[1:0] D18F2x94_dct[0]		D18F2x9C_x0000_0004_dct[0]_mp[1:0]		D18F2x9C_x0000_0000_dct[0]_mp[1:0]	
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	SlowAccessMode	POdtOff				
1	667, 800	1.5	SR, DR	-	0	0	00000000h		00002222h	
1	1066	1.5	SR	-	0	0	003D3D3Dh		10002222h	
1	1066	1.5	DR	-	0	0	00000000h		10002222h	
1	1333	1.5	SR	-	0	0	003D3D3Dh		20112222h	
1	1333	1.5	DR	-	0	0	00003D3Dh		20112222h	
1	1600, 1866	1.5	SR	-	0	0	003C3C3Ch		30332222h	
1	1600, 1866	1.5	DR	-	1	0	00003C3Ch		30332222h	
2	667, 800	1.5	NP	SR, DR	0	0	00000000h		00002222h	
2	667	1.5	SR, DR	SR, DR	1	0	00000000h		10222323h	
2	800	1.5	SR, DR	SR, DR	1	0	00000000h		20222323h	
2	1066	1.5	NP	SR	0	0	003D3D3Dh		10002222h	
2	1066	1.5	NP	DR	0	0	00000000h		10002222h	
2	1066, 1333, 1600	1.5	SR, DR	SR, DR	1	0	00000000h		30222323h	
2	1333	1.5	NP	SR	0	0	003D3D3Dh		20112222h	
2	1333	1.5	NP	DR	0	0	00003D3Dh		20112222h	

Table 51: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **UDIMM**

Condition					D18F2x9C_x0D0F_0[F;8:0]04_dct[0]_mpl[1:0]		D18F2x9C_x0000_0004_dct[0]_mpl[1:0]	
					D18F2x94_dct[0]			
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	SlowAccessMode	POdtOff		
2	1600, 1866	1.5	NP	SR	0	0	003C3C3Ch	30332222h
2	1600, 1866	1.5	NP	DR	1	0	00003C3Ch	30332222h

Table 52: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **SODIMM**

Condition					D18F2x9C_x0D0F_0[F:8:0]04_dct[0]_mp[1:0]		D18F2x9C_x0000_0004_dct[0]_mp[1:0]	D18F2x9C_x0000_0000_dct[0]_mp[1:0]
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	SlowAccessMode	POdtOff		
1	667, 800	1.5, 1.35, 1.25	SR, DR	-	0	0	00000000h	00002222h
1	1066	1.5, 1.35, 1.25	SR	-	0	0	003D3D3Dh	10002222h
1	1066	1.5, 1.35, 1.25	DR	-	0	0	00000000h	10002222h
1	1333	1.5, 1.35, 1.25	SR	-	0	0	003D3D3Dh	20112222h
1	1333	1.5, 1.35, 1.25	DR	-	0	0	00003D3Dh	20112222h
1	1600	1.5, 1.35	SR	-	0	0	003C3C3Ch	30332222h
1	1600	1.5, 1.35	DR	-	1	0	00003C3Ch	30332222h
1	1866	1.5	SR	-	0	0	003C3C3Ch	30332222h
1	1866	1.5	DR	-	1	0	00003C3Ch	30332222h
2	667, 800	1.5, 1.35, 1.25	NP	SR, DR	0	0	00000000h	00002222h
2	667	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h	10222323h
2	800	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h	20222323h
2	1066	1.5, 1.35, 1.25	NP	SR	0	0	003D3D3Dh	10002222h
2	1066	1.5, 1.35, 1.25	NP	DR	0	0	00000000h	10002222h
2	1066	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h	30222323h
2	1333	1.5, 1.35, 1.25	NP	SR	0	0	003D3D3Dh	20112222h
2	1333	1.5, 1.35, 1.25	NP	DR	0	0	00003D3Dh	20112222h
2	1333	1.5, 1.35	SR, DR	SR, DR	1	0	00000000h	30222323h
2	1333	1.25	SR	SR	1	0	00000000h	30222323h

Table 52: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **SODIMM**

Condition					D18F2x9C_x0D0F_0[F;8:0]04_dct[0]_mpl[1:0]		D18F2x9C_x0000_0004_dct[0]_mpl[1:0]	
					D18F2x94_dct[0]			
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	SlowAccessMode	POdtOff		
2	1600	1.5, 1.35	NP	SR	0	0	003C3C3Ch	30332222h
2	1600	1.5, 1.35	NP	DR	1	0	00003C3Ch	30332222h
2	1600	1.5	SR, DR	SR, DR	1	0	00000000h	30222323h
2	1600	1.35	SR	SR	1	0	00000000h	30222323h
2	1866	1.5	NP	SR	0	0	003C3C3Ch	30332222h
2	1866	1.5	NP	DR	1	0	00003C3Ch	30332222h

Table 53: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **SODIMM** plus **Solder-down DRAM**

Condition					D18F2x9C_x0D0F_0[F:8:0]04_dct[0]_mp[1:0] D18F2x94_dct[0]		D18F2x9C_x0000_0004_dct[0]_mp[1:0]		D18F2x9C_x0000_0000_dct[0]_mp[1:0]	
NumDimmSlots	DdrRate	VDDIO	DIMM0	DIMM1	SlowAccessMode	POdtOff				
2	667, 800	1.5, 1.35, 1.25	NP	SR, DR	0	0	00000000h		00002222h	
2	667	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h		10222323h	
2	800	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h		20222323h	
2	1066	1.5, 1.35, 1.25	NP	SR	0	0	003D3D3Dh		10002222h	
2	1066	1.5, 1.35, 1.25	NP	DR	0	0	00000000h		10002222h	
2	1066	1.5, 1.35, 1.25	SR, DR	SR, DR	1	0	00000000h		30222323h	
2	1333	1.5, 1.35	NP	SR	0	0	003D3D3Dh		20112222h	
2	1333	1.5, 1.35	NP	DR	0	0	00003D3Dh		20112222h	
2	1333	1.5	SR, DR	SR, DR	1	0	00000000h		30222323h	
2	1333	1.35	SR	SR	1	0	00000000h		30222323h	

Table 54: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **Solder-down DRAM**

Condition					D18F2x9C_x0D0F_0[F,8:0]04_dct[0]_mp[1:0]		D18F2x9C_x0000_0004_dct[0]_mp[1:0]		D18F2x9C_x0000_0000_dct[0]_mp[1:0]	
NumDimmSlots	DdrRate	VDDIO	DIMM0	SlowAccessMode	POdtOff					
1	667	1.5, 1.35, 1.25	SR, DR	0	1	00000000h			00000000h	
1	800	1.5, 1.35, 1.25	SR, DR	0	0	00000000h			00000000h	
1	1066	1.5, 1.35, 1.25	SR	0	0	003D3D3Dh			10000000h	
1	1066	1.5, 1.35, 1.25	DR	0	0	00000000h			10000000h	
1	1333	1.5, 1.35, 1.25	SR	0	0	003D3D3Dh			20000000h	
1	1333	1.5, 1.35, 1.25	DR	0	0	00003D3Dh			20110000h	
1	1600	1.5, 1.35	SR	0	0	003C3C3Ch			30110000h	
1	1600	1.5, 1.35	DR	1	0	00003C3Ch			30110000h	
1	1866	1.5	SR	0	0	003C3C3Ch			30110000h	
1	1866	1.5	DR	1	0	00003C3Ch			30110000h	

Table 55: BIOS recommendations for SlowAccessMode, POdtOff, Addr/Cmd Timings and Output Driver Control **Solder-down DRAM** Low Power Motherboard

Condition				D18F2x9C_x0D0F_0[F:8:0]04_dct[0]_mp[1:0]		D18F2x9C_x0000_0004_dct[0]_mp[1:0]	D18F2x9C_x0000_0000_dct[0]_mp[1:0]
NumDimmSlots	DdrRate	VDDIO	DIMM0	SlowAccessMode	POdtOff		
1	667	1.5, 1.35	SR, DR	0	1	00303030h	00000000h
1	800	1.5, 1.35	SR, DR	0	1	00303030h	00001111h
1	1066	1.5, 1.35	SR	0	1	00303030h	00002111h
1	1066	1.5, 1.35	DR	0	1	00303030h	00002222h
1	1333	1.5, 1.35	SR, DR	0	1	00303030h	00112222h

2.9.7.7 DCT Training Specific Configuration

The DCT requires certain features be disabled during DRAM device initialization and training. BIOS should program the registers in [Table 56](#) before DRAM device initialization and training. For normal operation, BIOS programs the recommended values if provided in [Table 56](#). BIOS must quiesce all other forms of DRAM traffic on the channel being trained. See [2.9.7 \[DCT/DRAM Initialization and Resume\]](#).

Table 56: DCT Training Specific Register Values

Register	Training	Normal Operation
D18F2x78_dct[0][AddrCmdTriEn]	0	1
D18F2x8C_dct[0][DisAutoRefresh]	1	0
D18F2x90_dct[0][ForceAutoPchg]	0	0
D18F2x90_dct[0][DynPageCloseEn]	0	0
D18F2x94_dct[0][BankSwizzleMode]	0	1
D18F2x94_dct[0][DcqBypassMax]	0	1Fh

Table 56: DCT Training Specific Register Values

Register	Training	Normal Operation
D18F2x94_dct[0][PowerDownEn]	0	1
D18F2x94_dct[0][ZqcsInterval]	00b	10b
D18F2x9C_x0000_000D_dct[0]_mp[1:0][RxMax-DurDllNoLock]	000b	See 2.9.7.10
D18F2x9C_x0000_000D_dct[0]_mp[1:0][TxMax-DurDllNoLock]	000b	See 2.9.7.10
D18F2x9C_x0D0F_0[F,8:0]10_dct[0]_mp[1:0][EnRxPadStandby]	0	See 2.9.7.10
D18F2xA4[CmdThrottleMode]	000b	See 2.9.12
D18F2xA4[ODTSEn]	000b	See 2.9.12
D18F2xA4[BwCapEn]	0	See 2.9.12
D18F2xA8_dct[0][BankSwap]	0	1
D18F3x58[DramScrub] ²	0	See 2.16.1.8
D18F3x5C[ScrubReDirEn] ²	0	IF (D18F3x44[DramEc-cEn]==1) THEN 1 ELSE 0 ENDIF
<ol style="list-style-type: none"> 1. Programmed specific to the current platform or memory configuration. 2. BIOS must quiesce all other forms of DRAM traffic on the channel when performing writes via D18F2x98_dct[0]. See also D18F3x88[DisDramScrub]. 		

2.9.7.8 DRAM Device and Controller Initialization

BIOS initializes the DRAM devices and the controller using a software controlled sequence. See 2.9.7.8.1 [Software DDR3 Device Initialization].

BIOS must observe additional requirements for changing the PLL frequency when setting D18F2x7C_dct[0][EnDramInit]. See 2.9.7.4.2 [DRAM Channel Frequency Change].

DRAM initialization is complete after the value of D18F2x7C_dct[0][EnDramInit] is written by BIOS from 1 to 0 in the software-controlled sequence.

2.9.7.8.1 Software DDR3 Device Initialization

BIOS should apply the following procedure to each DCT to initialize the DDR3 DIMMs on the channel. This procedure should be run only when booting from an unpowered state (ACPI S4, S5 or G3; not S3, suspend to RAM).

1. Program D18F2x7C_dct[0][EnDramInit] = 1.
2. Wait 200 us.
3. Program D18F2x7C_dct[0][DeassertMemRstX] = 1.
4. Wait 500 us.
5. Program D18F2x7C_dct[0][AssertCke] = 1.
6. Wait 360 ns.
7. Send MRS(2).
8. Send MRS(3). Ordinarily at this time, MrsAddress[2:0] = 000b.

9. Send MRS(1) with MrsAddress[7] = 0.
10. Send MRS(0) with MrsAddress[8] = 1.
11. Send two ZQCL commands.
- BIOS instructs the DCT to send a ZQCL command by programming [D18F2x7C_dct\[0\]](#) as follows:
 - Program MrsAddress[10] = 1.
 - Program SendZQCmd = 1.
 - Wait for SendZQCmd = 0.
 - Wait 512 MEMCLKs.
12. Program [D18F2x7C_dct\[0\]\[EnDramInit\]](#) = 0.
13. Program [D18F2x2E8_dct\[0\]_mp\[1:0\]](#), [D18F2x2EC_dct\[0\]_mp\[1:0\]](#) with a copy of the mode register data sent in the steps above, except with [MR0\[DLL\]](#) = 0.

2.9.7.8.1.1 DDR3 MR Initialization

BIOS instructs the DCT to send MRS commands by programming [D18F2x7C_dct\[0\]](#) as follows:

1. Program MrsBank and MrsAddress as specified below:
 - MrsBank[2:0] = BA2:BA0.
 - MrsAddress[15:0] = A15:A0.
 - BIOS may need to remap bits, see also [D18F2x\[5C:40\]_dct\[0\]\[OnDimmMirror\]](#).
 - Set all other bits in MrsAddress to zero. BIOS should write reserved fields as 0.
2. Program MrsChipSel as appropriate.
3. Program SendMrsCmd = 1.
4. Wait for SendMrsCmd = 0.

MR0 DDR3 MR0

Table 57: BIOS Recommendations for [MR0\[WR\]](#)

Condition	MR0
D18F2x22C_dct[0]_mp[1:0][Twr]	WR[3:0]
10h	0000b
5h	0001b
6h	0010b
7h	0011b
8h	0100b
Ah	0101b
Ch	0110b
Eh	0111b
12h	1001b

Table 58: BIOS Recommendations for MR0[CL[3:0]]

Condition	MR0
D18F2x200_dct[0]_mp[1:0][Tcl]	CL[3:0]
5h	2h
6h	4h
7h	6h
8h	8h
9h	Ah
Ah	Ch
Bh	Eh
Ch	1h
Dh	3h
Eh	5h
Fh	7h
10h	9h
11h	Bh

Bits	Description
15:14	Reserved.
13	WR[3]: write recovery for autoprecharge. See WR[2:0].
12	PPD: DLL control for precharge powerdown. BIOS: D18F2x84_dct[0][PchgPDMoSel].
11:9	WR[2:0]: write recovery for autoprecharge. WR[3:0] = {WR[3], WR[2:0]}. BIOS: Table 57.
8	DLL: DLL reset. BIOS: See 2.9.7.8.1.
7	TM: test mode. BIOS: 0.
6:4	CL[3:1]. CAS latency. See: CL[0].
3	RBT: read burst type. BIOS: 1.
2	CL[0]. CAS latency. CL[3:0] = {CL[3:1], CL[0]}. BIOS: Table 58.
1:0	BL: burst length. BIOS: D18F2x84_dct[0][BurstCtrl].

MR1 DDR3 MR1

Bits	Description
15:13	Reserved.
12	Qoff: Qoff. BIOS: See 2.9.7.9.1 .
11	TDQS: TDQS enable. BIOS: 0.
10	Reserved.
9	RttNom[2]: RttNom. See: RttNom[0].
8	Reserved.
7	Level: write leveling enable. BIOS: See 2.9.7.9.1 .
6	RttNom[1]: RttNom. See: RttNom[0].
5	DIC[1]: output driver impedance control. See: DIC[0].
4:3	AL: additive latency. BIOS: 0.
2	RttNom[0]: RttNom. RttNom[2:0] = {RttNom[2], RttNom[1], RttNom[0]}. BIOS: See 2.9.7.6.5.1
1	DIC[0]: output driver impedance control. DIC[1:0] = {DIC[1], DIC[0]}. BIOS: 01b.
0	DLL: DLL enable. BIOS: 0.

MR2 DDR3 MR2

Table 59: BIOS Recommendations for MR2[ASR, SRT]

Condition		MR2	
AutoSelfRefresh	ExtendedTemperature-Range	ASR	SRT
0	0	0	0
0	1	0	1
1	-	1	0

Bits	Description
15:11	Reserved. MR2
10:9	RttWr: RttWr. BIOS: See 2.9.7.6.5.1 .
8	Reserved.
7	SRT: self refresh temperature range. BIOS: Table 59 .
6	ASR: auto self refresh. BIOS: Table 59 .
5:3	CWL: CAS write latency. BIOS: D18F2x20C_dct[0]_mp[1:0][Tcwl] - 5.
2:0	PASR: partial array self refresh. BIOS: 0.

MR3 DDR3 MR3

Bits	Description
15:3	Reserved.
2	MPR: MPR operation. BIOS: 0.
1:0	MPRLoc: MPR location. BIOS: 0.

2.9.7.9 DRAM Training

This section describes detailed methods used to train the processor DDR interface to DRAM for optimal functionality and performance. DRAM training is performed by BIOS after initializing the DRAM controller. See [2.9.7.8 \[DRAM Device and Controller Initialization\]](#).

Some of the DRAM training steps described in this section require two passes if the target MEMCLK frequency is greater than 333 MHz. For optimal software performance, software may defer the second pass (at target MEMCLK frequency) for each training step until after the first pass (at lowest supported frequency) of all other training steps are complete. See [D18F2x94_dct\[0\]\[MemClkFreq\]](#).

Product specific training requirements are as follows:

- Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[TrNibbleSel\]](#)=0.
- Program [D18F2xA8_dct\[0\]\[PerRankTimingEn\]](#)=1.

See [2.9.7.7 \[DCT Training Specific Configuration\]](#) for additional training requirements.

In the following subsections, lane is used to describe an 8-bit wide data group, each with its own timing control.

2.9.7.9.1 Write Levelization Training

Write levelization involves using the phy to detect the edge of DQS with respect to the memory clock on the DIMM for write accesses to each lane.

If ([D18PDBypassMode](#)) then

- For each rank and lane: Program [D18F2x9C_x0000_00\[4A:30\]_dct\[0\]_mp\[1:0\]\[WrDqsGrossDly, WrDqs-FineDly\]](#) = {0, 0}.
- Skip Write Levelization Training

Training is accomplished on a per channel, per rank basis. If the target frequency is greater than 333 MHz then BIOS performs two passes; otherwise, only one pass is required. See [2.9.7.4.2 \[DRAM Channel Frequency Change\]](#).

- Pass 1: Configure the memory subsystem for 333 MHz MEMCLK frequency.
- Pass 2: Configure the memory subsystem for the target MEMCLK frequency.

The following describes the steps used for each pass of write levelization training for each channel:

For each rank:

1. Prepare the DIMMs for write levelization using DDR3-defined MR commands.

- A. Configure the output driver and on-die termination of the target DIMM as follows:
 - For the target rank of the target DIMM, enable write leveling mode and enable the output driver.
 - For all other ranks of the target DIMM, enable write leveling mode and disable the output driver.
 - For two or more DIMMs per channel, program Rtt_Nom of the target rank to the corresponding specified Rtt_Wr termination. Otherwise, configure Rtt_Nom of the target DIMM as normal. See [2.9.7.6.6 \[DRAM Address Timing and Output Driver Compensation Control\]](#).
- B. Configure Rtt_Nom on the non-target DIMMs as normal. See [2.9.7.6.6 \[DRAM Address Timing and Output Driver Compensation Control\]](#).
2. Wait 40 MEMCLKs.
3. Configure the phy for write levelization training:
 - A. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvTrEn\]=0](#).
 - B. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[TrChipSel\]](#) to specify the target rank to be trained.
 - C. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvOdt\]](#) to the proper ODT settings for the current memory subsystem configuration. See [2.9.7.6.5 \[DRAM ODT Control\]](#).
 - D. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvOdtEn\]=1](#).
 - E. MFENCE.
 - F. Wait 10 MEMCLKs to allow for ODT signal settling.
 - G. For each lane program an initial value to registers [D18F2x9C_x0000_00\[52:50\]_dct\[0\]](#) to set the gross and fine delay. See [2.9.7.9.1.1 \[Write Leveling Seed Value\]](#).
4. Perform write leveling of the devices on the DIMM:
 - A. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvTrEn\]=1](#).
 - B. MFENCE.
 - C. Wait 200 MEMCLKs.
 - D. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvTrEn\]=0](#).
 - E. Read from registers [D18F2x9C_x0000_00\[52:50\]_dct\[0\]](#) to get the gross and fine delay settings for the target DIMM and save these values.
5. Disable write levelization training so that the phy stops driving write levelization ODT.
 - A. Program [D18F2x9C_x0000_0008_dct\[0\]_mp\[1:0\]\[WrLvOdtEn\]=0](#).
 - B. MFENCE.
 - C. Wait 10 MEMCLKs to allow for ODT signal settling.
6. Program the target DIMM back to normal operation by configuring the following:
 - A. Configure all ranks of the target DIMM for normal operation.
 - B. Enable the output drivers of all ranks of the target DIMM.
 - C. For a two or more DIMM system, program the Rtt_Nom value for the target DIMM to the normal operating termination.

For each rank:

- BIOS calculates and programs the final saved gross and fine delay values for each lane into [D18F2x9C_x0000_00\[4A:30\]_dct\[0\]_mp\[1:0\]](#) [\[DRAM DQS Write Timing\]](#).
 - $WrDqsFineDly = PhRecFineDly$.
 - $GrossDly = SeedGross + PhRecGrossDly - SeedPreGross$.
 - The Critical Gross Delay (CGD) is the minimum GrossDly of all byte lanes and all DIMMs.
 - If $(CGD < 0)$ Then
 - [D18F2x20C_dct\[0\]_mp\[1:0\]\[WrDqDqsEarly\] = ABS\(CGD\)](#)
 - $WrDqsGrossDly = GrossDly + WrDqDqsEarly$
 - Else
 - [D18F2x20C_dct\[0\]_mp\[1:0\]\[WrDqDqsEarly\] = 0](#).
 - $WrDqsGrossDly = GrossDly$.

2.9.7.9.1.1 Write Leveling Seed Value

The seed value for pass 1 of write leveling is design and platform specific. The platform vendor may need to characterize and adjust this value for proper write levelization training. The seed delay value must fall within +/- 1/2 MEMCLK, including silicon PVT margin and jitter of the measured clock delay.

1. Calculate the total seed based on the following:
 - Pass 1: SeedTotal = configuration specific seed value found in [Table 60](#).
 - Pass N:
 - SeedTotalPreScaling = the total delay values obtained from the previous (N-1) pass of write levelization training.
 - Write Leveling Total Delay = `D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0][WrDqsGrossDly, WrDqsFineDly] - (0x20 * D18F2x20C_dct[0]_mp[1:0][WrDqDqsEarly])`
 - SeedTotal = SeedTotalPreScaling*(target frequency)/(frequency from previous pass).
2. SeedGross = SeedTotal DIV 32.
3. SeedFine = SeedTotal MOD 32.
4. If (SeedGross is odd)
 - then SeedPreGross = 1
 - else SeedPreGross = 2.
5. Program `D18F2x9C_x0000_00[52:50]_dct[0][PhRecFineDly]` = SeedFine.
6. Program `D18F2x9C_x0000_00[52:50]_dct[0][PhRecGrossDly]` = SeedPreGross.

Table 60: DDR3 Write Leveling Seed Values

DIMM Type	Seed Value ¹
Solder-down DRAM	0Eh
SODIMM	0Eh
UDIMM	15h
1. DDR3-667 (333 MHz).	

2.9.7.9.2 DQS Receiver Enable Training

Receiver enable delay training is used to dynamically determine the optimal delay value for `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]` [DRAM DQS Receiver Enable Timing]. The optimal DQS receiver enable delay value is platform and load specific, and occurs in the middle of a received read preamble. The timing of the preamble includes the inbound DQS propagation delay, which is unknown by BIOS. The training for delay values involves:

1. Configuring the phy for an initial expected phase value (seed).
2. Generating a stream of read DQS edges from the DRAM by issuing multiple read commands.
3. The phy determining the phase between the received DQS edges and a reference clock.
4. Calculating a final delay value for enabling receivers during normal read operations using the phase determined by the phy.

Prior to DQS Receiver Enable Training, BIOS must program `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]` based on the seeded value of `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]`. See 2.9.7.9.6 [Calculating MaxRdLatency].

Training is accomplished on a per channel, per rank basis. If the target frequency is greater than 333 MHz then BIOS performs two passes; otherwise only one pass is required. See 2.9.7.4.2 [DRAM Channel Frequency Change].

- Pass 1: Configure the memory subsystem for 333 MHz MEMCLK frequency.
- Pass 2: Configure the memory subsystem for the target MEMCLK frequency.

The following describes the steps used for each pass of receiver enable training for each channel:

For each rank:

1. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0]`[TrChipSel] to specify the target rank to be trained.
2. For each lane program an initial value to registers `D18F2x9C_x0000_00[52:50]_dct[0]` to set the gross and fine delay as specified in 2.9.7.9.2.1 [DQS Receiver Enable Training Seed Value].
3. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0]`[DqsRcvTrEn]=1.
4. Issue 192 read requests to the target rank. See 2.9.8 [Continuous Pattern Generation].
5. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0]`[DqsRcvTrEn]=0.
6. Read `D18F2x9C_x0000_00[52:50]_dct[0]`[PhRecGrossDly, PhRecFineDly] to get the gross and fine delay values for each lane.
7. For each lane, calculate and program the corresponding receiver enable delay values for `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]`[DqsRcvEnGrossDelay, DqsRcvEnFineDelay]. Save the result for use later.
 - $DqsRcvEnFineDelay = PhRecFineDly$.
 - $DqsRcvEnGrossDelay = SeedGross + PhRecGrossDly - SeedPreGross + 1$.

2.9.7.9.2.1 DQS Receiver Enable Training Seed Value

The seed value for pass 1 of receiver enable delay training is design and platform specific and should be determined by characterization for best performance. The seed value represents the total delay from a reference point to the first expected rise edge of DQS on a read CAS measured at the processor pins, in 1 UI/32 increments. The reference point is defined as the clock in which CAS is asserted + CL - 1.

The following steps are taken to determine the seed values needed to program the DRAM Phase Recovery Control Registers:

For each pass and each lane:

1. Calculate the total seed based on the following:
 - Pass 1: $SeedTotal = \text{The seed value found in Table 61} + \text{the total delay values obtained from the first pass of write levelization training. See 2.9.7.9.1 [Write Levelization Training].}$
 - $\text{Write Leveling Total Delay} = D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0][WrDqsGrossDly, WrDqsFineDly] - (0x20 * D18F2x20C_dct[0]_mp[1:0][WrDqDqsEarly])$
 - Pass N:
 - $RegisterDelay = 0$
 - $SeedTotalPreScaling = (\text{the total delay values in } D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0] \text{ from the previous (N-1) pass of training}) - RegisterDelay - 20h.$
 - $SeedTotal = RegisterDelay + FLOOR(SeedTotalPreScaling * (\text{target frequency}) / (\text{frequency from previous pass}))$.
2. $SeedGross = SeedTotal \text{ DIV } 32$.
3. $SeedFine = SeedTotal \text{ MOD } 32$.
4. If (SeedGross is odd)
 - then $SeedPreGross = 1$
 - else $SeedPreGross = 2$.

5. Program `D18F2x9C_x0000_00[52:50]_dct[0][PhRecFineDly] = SeedFine`.
6. Program `D18F2x9C_x0000_00[52:50]_dct[0][PhRecGrossDly] = SeedPreGross`.
7. Program `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay] = IF ((NBCOF / DdrRate < 1) && (D18F2x200_dct[0]_mp[1:0][Tcl]=5) && (SeedGross<1) THEN 1 ELSE SeedGross ENDIF`.

Table 61. DDR3 DQS Receiver Enable Training Seed Values

DIMM Type	Seed Value ¹
Solder-down DRAM	20h
SODIMM	32h
UDIMM	32h
1. DDR3-667 (333 MHz)	

2.9.7.9.3 DQS Receiver Enable Cycle Training

Receiver enable delay cycle training is used to train the gross delay settings of `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]` to the middle of the received read preamble using the phy phase results.

For each rank and lane:

1. Program `D18F2x9C_x0D0F_0[F,8:0]30_dct[0][BlockRxDqsLock] = 1`.
2. `RxEnOrig = D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay]` result from 2.9.7.9.2 [DQS Receiver Enable Training].
3. `RxEnOffset = MOD(RxEnOrig + 10h, 40h)`
4. For each `DqsRcvEn` value beginning from `RxEnOffset` incrementing by 1 MEMCLK:
 - A. Program `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay]` with the current value.
 - B. Perform 2.9.7.9.5 [DQS Position Training].
 - Record the result for the current `DqsRcvEn` setting as a pass or fail depending if a data eye is found.
5. Process the array of results and determine a pass-to-fail transition.
 - A. `DqsRcvEnCycle` = the total delay value of the pass result.
 - B. Program `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay] = DqsRcvEnCycle - 10h`.
6. Program `D18F2x9C_x0D0F_0[F,8:0]30_dct[0][BlockRxDqsLock] = 0`.

2.9.7.9.4 DQS Receiver Enable DllPDBypassMode Adjustment

In `DllPDBypassMode` BIOS performs the following to adjust the trained `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]` receiver enable delay values and then sets the power down/bypass for the the DLL. `BypassFlopDelay` is trained in a manner similar to 2.9.7.4.3 [Phy Fence Programming].

Train `BypassFlopDelay` as follows:

1. Program `D18F2x9C_x0000_0008_dct[0]_mp[1:0][FenceTrSel]=00b`.
2. Program `D18F2x9C_x0000_00[52:50]_dct[0]=1010_1010h`.
3. Perform phy fence training on a per-lane basis. See 2.9.7.4.3.1 [Phy Fence Training].
4. Save the per-lane results as `BypassFlopDelay`.

For each rank and lane:

1. AdjDelay = D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay] - BypassFlopDelay + 8.
2. AdjDelayGross = AdjDelay DIV 32.
3. AdjDelayFine = AdjDelay & 10h.
4. Program D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay] = {AdjDelayGross, AdjDelayFine}.
5. Program D18F2x9C_x0D0F_0[F,8:0]1E_dct[0]_mp[1:0][DlIPDBypass] = 1.

2.9.7.9.5 DQS Position Training

DQS position training is used to place the DQS strobe in the center of the read DQ data eye and to center the write DQ data eye across the write DQS strobe. Determining the correct DRAM DQS and DQ delay settings for both reads and writes is conducted by performing a two dimensional search of the delay settings found in D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0] [DRAM Read DQS Timing] and D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0] [DRAM Write Data Timing].

Training is accomplished on a per channel, per rank, and per lane basis.

For DQS position training, BIOS generates a training pattern using continuous read or write data streams. A 2k-bit-time training pattern is recommended for optimal results. To achieve this, BIOS programs D18F2x260_dct[0][CmdCount] = 256, D18F2x250_dct[0][CmdTgt]=01b, and D18F2x25[8,4]_dct[0] to access two different banks of the same CS. See 2.9.8 [Continuous Pattern Generation].

Prior to DQS position training, BIOS must program D18F2x210_dct[0]_nbp[3:0][MaxRdLatency] based on the current greatest value of D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]. See 2.9.7.9.6 [Calculating MaxRdLatency].

The following describes the steps used for DQS position training for each channel:

- Program D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0] for all lanes.
 - RxDqInsDly = 0.

For each rank and lane:

1. Select a 64 byte aligned test address.
2. If (DlIPDBypassMode) then
Program D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][WrDatGrossDly, WrDatFineDly] = {0, 10h}.
Else
For each write data delay value in D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0] from Wr-DQS to Wr-DQS plus 1 UI, using the Wr-DQS delay value found in 2.9.7.9.1 [Write Levelization Training]:
 - Program the write data delay value for the current lane.
 - Write the DRAM training pattern to the test address.
3. For each read DQS delay value in D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0] from 0 to 1 UI:
 - Program the read DQS delay value for the current lane.
 - Read the DRAM training pattern from the test address.
 - Record the result for the current settings as a pass or fail depending if the pattern is read correctly.
 - Process the array of results and determine the longest string of consecutive passing read DQS delay values.

- If the read DQS delay results for the current lane contain three or more consecutive passing delay values, then program `D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0]` with the average value of the smallest and largest delay values in the string of consecutive passing results.
 - If the average value of passing read DQS delay for the lane is negative, then adjust the input receiver DQ delay in `D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0][RxDqInsDly]` for the lane as follows:
 - IF `(!D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0][LowPowerRcvrEn] & RxDqInsDly < 3)` THEN increment `RxDqInsDly` and repeat step 3 above for all ranks and lanes.
 - ELSE program the read DQS delay for the lane with a value of zero.
 - ENDIF.
4. Process the array of results and determine the longest string of consecutive passing write data delay values for the read DQS delay value found in the step above.
- If the write data delay results for the current lane contain three or more consecutive passing delay values, then program `D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0]` with the average value of the smallest and largest delay values in the string of consecutive passing results.

See Figure 3.

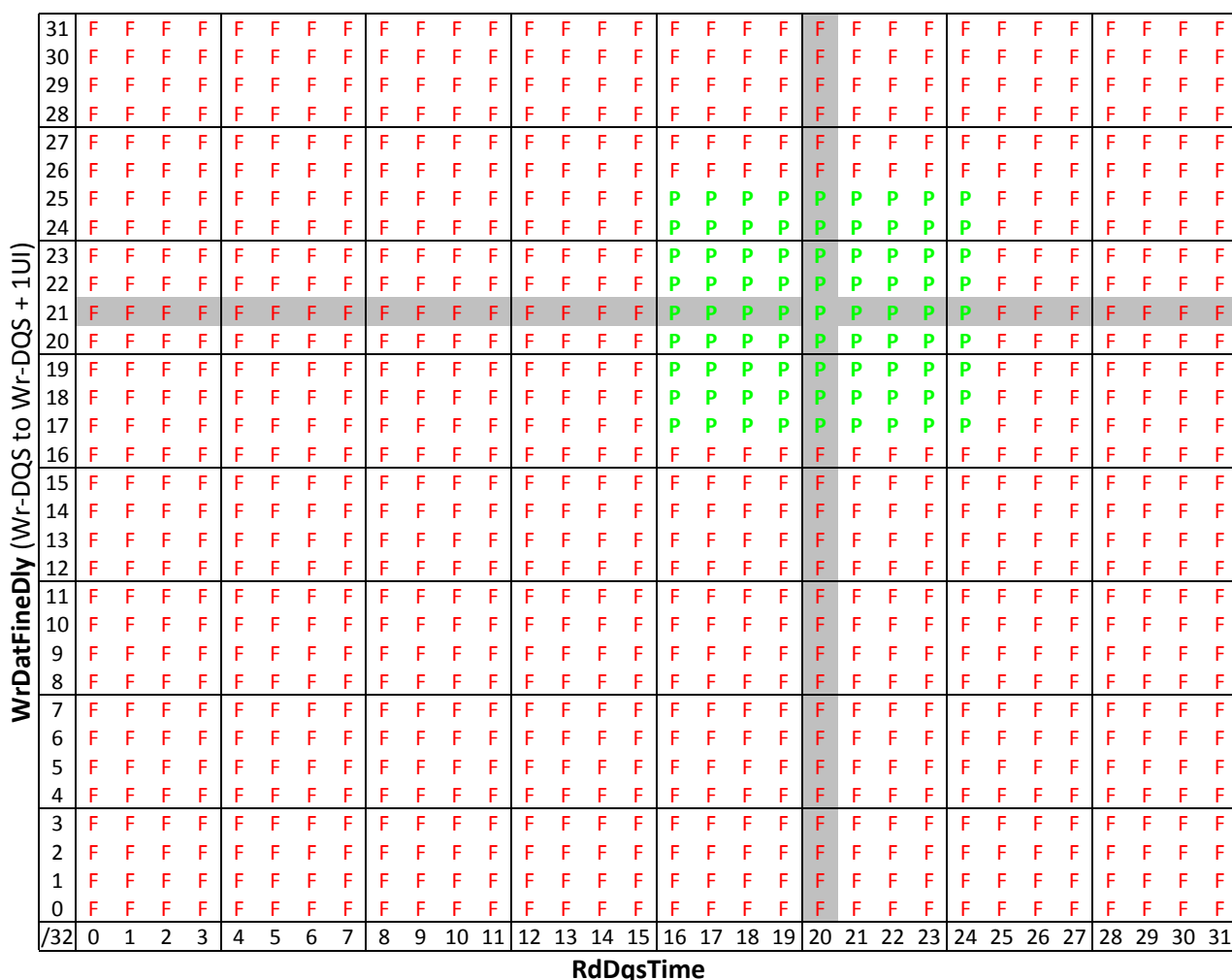


Figure 3: DQS Position Training Example Results

In some cases, a non-zero process, voltage, and temperature dependent insertion delay is added to the DLL pro-

As shown in Figure 4, for each delay setting BIOS records a passing result of P_{Φ} for the data comparison shifted by one bit time if the data at bit times $N=0, 1, \dots, 6$, is read correctly when compared against the data written at bit times $N=1, 2, \dots, 7$. In the array of results, these passing values make up the left piece of information that had been lost due to insertion delay. In order to process the array of results, BIOS calculates the read DQS delay value for a P_{Φ} result as $RdDqsTimeByte$ minus 1 UI.



2.9.7.9.6 Calculating MaxRdLatency

The MaxRdLatency value determines when the memory controller can receive incoming data from the DCTs. Calculating MaxRdLatency consists of summing all the synchronous and asynchronous delays in the path from the processor to the DRAM and back at a given MEMCLK frequency. BIOS incrementally calculates the MaxRdLatency and then finally programs the value into `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]`.

The following steps describe the algorithm used to compute `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]` used for DRAM training. P, N, and T are used as a temporary placeholders for the incrementally summed value.

1. $P = N = T = 0$
2. If `(D18F2x9C_x0000_0004_dct[0]_mp[1:0][AddrCmdSetup] = 0 & D18F2x9C_x0000_0004_dct[0]_mp[1:0][CsOdtSetup] = 0 & D18F2x9C_x0000_0004_dct[0]_mp[1:0][CkeSetup] = 0)`
then $P = P + 1$
else $P = P + 2$
3. $P = P + (8 - D18F2x210_dct[0]_nbp[3:0][RdPtrInit])$
4. $P = P + NumPclks$
 - $NumPclks = 6$
5. $P = P + (2 * (D18F2x200_dct[0]_mp[1:0][Tcl] - 1 \text{ clocks}))$
6. $P = P + CEIL(MAX(D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay] + D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0][RdDqsTime] PCLKs)) + 1$
 - Prior to DQS position training, use maximum value for RdDqsTime.
7. If $(NclkFreq/MemClkFreq < 2)$ then $P = P + 4.5$
Else $P = P + 2.5$
8. $T = T + 1050 \text{ ps}$
9. $N = (P/(MemClkFreq * 2) + T) * NclkFreq$
 - See `D18F5x16[C:0][NbDid, NbFid]` and `D18F2x94_dct[0][MemClkFreq]`.
10. `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency] = CEIL(N) + NumNclks`
 - $NumNclks = 1$

2.9.7.9.6.1 MaxRdLatency Training

After DRAM DQS receiver enable training, BIOS optimizes `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]` using the following algorithm. For MaxRdLatency training, BIOS generates a training pattern using continuous read or write data streams. See 2.9.8 [Continuous Pattern Generation].

For each channel:

1. Calculate a starting MaxRdLatency delay value by executing the steps in 2.9.7.9.6, excluding steps 4, 7, 8, and 10.
2. Select 256 64-byte aligned test addresses associated with the rank that has the worst case `(D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay, DqsRcvEnFineDelay] + D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0][RdDqsTime])` register setting.
3. Write the DIMM test addresses with the training pattern.
4. For each MaxRdLatency value incrementing from the value calculated in step 1:
 - A. Program `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]` with the current value.
 - B. Read the DIMM test addresses.
 - C. Compare the values read against the pattern written.
 - If the pattern is read correctly, go to step 5.
 - D. Program `D18F2x9C_x0000_0050_dct[0]=00000000h`

5. Program `D18F2x210_dct[0]_nbp[3:0][MaxRdLatency]` = `CEIL(current value + 1 NCLK + 1.5 MEMCLK ENDIF + IF (NclkFreq/MemClkFreq < 2) THEN 0.5 MEMCLK ELSE 0 ENDIF)` .

2.9.7.10 DRAM Phy Power Savings

For power savings, BIOS should perform the following actions for each channel:

1. Program `D18F2x88_dct[0][MemClkDis]` to disable unused MEMCLK pins.
2. Program `D18F2x9C_x0D0F_2[F,2:0]30_dct[0][PwrDn]` for unused MEMCLK pairs.
3. Program `D18F2x9C_x0D0F_0[F,8:0]30_dct[0][PwrDn]` to disable the ECC lane if `D18F2x90_dct[0][DimmEccEn]==0`.
4. Program `D18F2x9C_x0000_000C_dct[0][CKETri, ODTTri, ChipSelTri]` to disable unused pins.
5. Program `D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0][DlIDisEarlyU]` = 1.
6. Program `D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0][DlIDisEarlyL]` = 1.
7. `D18F2x9C_x0D0F_812F_dct[0][PARTri]` = 1.
8. `D18F2x9C_x0D0F_812F_dct[0][Add17Tri, Add16Tri]` = { 1b, 1b }
9. Program `D18F2x9C_x0D0F_0[F,8:0]10_dct[0]_mp[1:0][EnRxPadStandby]` = `IF (DdrRate <= 1600) THEN 1 ELSE 0 ENDIF`.
10. Program `D18F2x9C_x0000_000D_dct[0]_mp[1:0]` as follows:
 - If `(DdrRate <= 1600)` `TxMaxDurDlIDisNoLock` = `RxMaxDurDlIDisNoLock` = 8h
else `TxMaxDurDlIDisNoLock` = `RxMaxDurDlIDisNoLock` = 7h.
 - `TxCPUUpdPeriod` = `RxCPUUpdPeriod` = 011b.
 - `TxDLLWakeupTime` = `RxDLLWakeupTime` = 11b.
11. Program `D18F2x9C_x0D0F_0[F,8:0]1C_dct[0]_mp[1:0]` as follows:
 - If `D18F2x90_dct[0][DimmEccEn]` Numlanes = 9 Else Numlanes = 8.
 - If `(DdrRate >= 1866)` `DllWakeTime` = 1 Else `DllWakeTime` = 0.
 - Let `MaxRxStggrDly` = `((Tcl-1)*2) + MIN(DqsRcvEnGrossDelay for all byte lanes) - 6`.
 - See `D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]`.
 - Let `dRxStggrDly` = `(MaxRxStggrDly - DllWakeTime) / (Numlanes - 1)`.
 - For each byte lane in the ordered sequence below, program `RxDllStggrDly[5:0]` = an increasing value, starting with 0 for the first byte lane in the sequence and increasing at a rate of `dRxStggrDly` for each subsequent byte lane.
 - Sequence: If `D18F2x90_dct[0][DimmEccEn]` { 8, 4, 3, 5, 2, 6, 1, 7, 0 } else { 4, 3, 5, 2, 6, 1, 7, 0 }.
 - Let `MaxTxStggrDly` = `MIN(((Tcwl-1)*2) + MIN(WrDqsGrossDly for all byte lanes) - WrDqDqsEarly - 4, MaxRxStggrDly)`
 - See `D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0]`.
 - See `D18F2x20C_dct[0]_mp[1:0]`.
 - Let `dTxStggrDly` = `(MaxTxStggrDly - DllWakeTime) / (Numlanes - 1)`.
 - For each byte lane in the ordered sequence below, program `TxDllStggrDly[5:0]` = an increasing integer value, starting with 0 for the first byte lane in the sequence and increasing at a rate of `dTxStggrDly` for each subsequent byte lane.
 - Sequence: If `D18F2x90_dct[0][DimmEccEn]` { 0, 7, 1, 6, 2, 5, 3, 4, 8 } else { 0, 7, 1, 6, 2, 5, 3, 4 }.
 - `RxDllStggrEn` = `TxDllStggrEn` = 1.
12. Program `D18F2x248_dct[0]_mp[1:0]` and then `D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0]` as follows:
 - For M0 & M1 context program `RxChMntClkEn`=`RxSsbMntClkEn`=0.
13. Program `D18F2x9C_x0D0F_0[F,8:0]30_dct[0][TxPclkGateEn, PchgPdPclkGateEn, DataCtlPipePclkGateEn]` = { 1, 1, 1 }.
14. Program `D18F2x9C_x0D0F_0[F,8:0]04_dct[0]_mp[1:0][TriDM]` = `IF (DataMaskMbType == 0) THEN 1 ELSE 0 ENDIF`.

2.9.8 Continuous Pattern Generation

DRAM training relies on the ability to generate a string of continuous reads or writes between the processor and DRAM, such that worst case electrical interactions can be created. This section describes how these continuous strings of accesses may be generated.

2.9.8.1 DCT Training Pattern Generation

DCT training pattern generation uses pattern generators in the DCT to generate controlled read and write traffic streams. During write pattern generation, data values based off of a deterministic pattern are burst to the DRAM interface. Conversely for reads, data bursts from the DRAM interface are compared against expected data values on a per nibble basis.

Two address modes are available for DRAM training pattern generation, as configured by [D18F2x250_dct\[0\]\[CmdTgt\]](#). For generating a stream of reads or writes to the same rank, address target A mode is used. To generate a stream of accesses to up to two different ranks, address target A and B mode is used.

An overview of the BIOS sequence to generate training patterns is as follows:

- Configure the DCT for pattern generation. See [2.9.7.7 \[DCT Training Specific Configuration\]](#).
- Ensure DIMMs are configured to support 8-beat bursts (BL8 or dynamic burst length on the fly).
- Wait for [D18F2x250_dct\[0\]\[CmdSendInProg\]](#) = 0.
- Program [D18F2x250_dct\[0\]\[CmdTestEnable\]](#) = 1.
- Send activate commands as appropriate. See [2.9.8.1.1 \[Activate and Precharge Command Generation\]](#).
- Send read or write commands as desired. See [2.9.8.1.2 \[Read and Write Command Generation\]](#).
- Send precharge commands as appropriate. See [2.9.8.1.1 \[Activate and Precharge Command Generation\]](#).
- Program [D18F2x250_dct\[0\]\[CmdTestEnable\]](#) = 0.

2.9.8.1.1 Activate and Precharge Command Generation

Prior to sending read or write commands, BIOS must send an activate command to a row in a particular bank of the DRAM devices for access. To send an activate command, BIOS performs the following steps:

- Program [D18F2x28C_dct\[0\]](#) to the desired address as follows:
 - [CmdChipSelect](#) = CS[7:0].
 - [CmdBank](#) = BA[2:0].
 - [CmdAddress](#) = A[17:0].
- Program [D18F2x28C_dct\[0\]\[SendActCmd\]](#) = 1.
- Wait until [D18F2x28C_dct\[0\]\[SendActCmd\]](#) = 0.
- Wait 75 MEMCLKs.

After completing its accesses, BIOS must deactivate open rows in the DRAM devices. To send a precharge or precharge all command to deactivate open rows in a bank or in all banks, BIOS performs the following steps:

- Wait 25 MEMCLKs.
- Program [D18F2x28C_dct\[0\]](#) to the desired address as follows:
 - [CmdChipSelect](#) = CS[7:0].
 - Precharge all command:
 - [CmdAddress\[10\]](#) = 1.
 - Precharge command:
 - [CmdAddress\[10\]](#) = 0.
 - [CmdBank](#) = BA[2:0].
- Program [D18F2x28C_dct\[0\]\[SendPchgCmd\]](#) = 1.

- Wait until `D18F2x28C_dct[0][SendPchgCmd] = 0`.
- Wait 25 MEMCLKs.

2.9.8.1.2 Read and Write Command Generation

BIOS performs the following steps for read pattern generation:

- Program `D18F2x27C_dct[0]`, `D18F2x278_dct[0]`, and `D18F2x274_dct[0]` with the data comparison masks for bit lanes of interest.
- Program `D18F2x270_dct[0][DataPrbsSeed]` the seed for the desired PRBS.
- Program `D18F2x260_dct[0][CmdCount]` equal to the number of cache line commands.
- Program `D18F2x25C_dct[0][BubbleCnt, CmdStreamLen]`. See 2.9.8.1.5 [BubbleCnt and CmdStream-Len Programming].
- Program `D18F2x25[8,4]_dct[0]` to the initial address.
- Program `D18F2x250_dct[0]` as follows:
 - ResetAllErr and StopOnErr as desired. See 2.9.8.1.4 [Data Comparison].
 - CmdTgt corresponding to `D18F2x25[8,4]_dct[0]`.
 - CmdType = 000b.
 - SendCmd = 1.
- If `D18F2x260_dct[0][CmdCount] != 0` then
 - Wait for `D18F2x250_dct[0][TestStatus] = 1` and `D18F2x250_dct[0][CmdSendInProg] = 0`.
 - Else
 - Wait the desired amount of time.
 - Program `D18F2x260_dct[0][CmdCount] = 1`.
 - Wait for `D18F2x250_dct[0][TestStatus] = 1` and `D18F2x250_dct[0][CmdSendInProg] = 0`.
- Program `D18F2x250_dct[0][SendCmd] = 0`.
- Read `D18F2x264_dct[0]`, `D18F2x268_dct[0]`, and `D18F2x26C_dct[0]` if applicable.

BIOS performs the following steps for write pattern generation:

- Program `D18F2x270_dct[0][DataPrbsSeed]` the seed for the desired PRBS.
- Program `D18F2x260_dct[0][CmdCount]` equal to the number of cache line commands desired.
- Program `D18F2x25C_dct[0][BubbleCnt, CmdStreamLen]`. See 2.9.8.1.5 [BubbleCnt and CmdStream-Len Programming].
- Program `D18F2x25[8,4]_dct[0]` to the initial address.
- Program `D18F2x250_dct[0]` as follows:
 - CmdTgt corresponding to `D18F2x25[8,4]_dct[0]`.
 - CmdType = 001b.
 - SendCmd = 1.
- If `D18F2x260_dct[0][CmdCount] != 0` then
 - Wait for `D18F2x250_dct[0][TestStatus] = 1` and `D18F2x250_dct[0][CmdSendInProg] = 0`.
 - Else
 - Wait the desired amount of time.
 - Program `D18F2x260_dct[0][CmdCount] = 1`.
 - Wait for `D18F2x250_dct[0][TestStatus] = 1` and `D18F2x250_dct[0][CmdSendInProg] = 0`.
- Program `D18F2x250_dct[0][SendCmd] = 0`.

BIOS combines the two sets of steps listed above for alternating write and read pattern generation.

2.9.8.1.3 Configurable Data Patterns

In addition to PRBS mode, `D18F2x250_dct[0][DataPatGenSel]` and `D18F2x2[B4,B0,AC,A8]_dct[0]` allow

configurable data pattern generation.

Table 62. Configurable Data Pattern Example with 1 Address Target

DQ/ Beat	Write TgtA Cmd 0								Write TgtA Cmd 1								Write TgtA Cmd 2								...
	Beat 0	Beat 1	Beat 2	Beat 3	Beat 4	Beat 5	Beat 6	Beat 7	Beat 8	Beat 9	Beat 10	Beat 11	Beat 12	Beat 13	Beat 14	Beat 15	Beat 16	Beat 17	Beat 18	Beat 19	Beat 20	Beat 21	Beat 22	Beat 23	...
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	
2	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	
3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	
4	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	
5	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	
6	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	
7	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	
8	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	
9	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	
10	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
11	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	
12	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
13	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	
14	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
...																									
ECC0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ECC1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	
ECC2	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	
ECC3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	
ECC4	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	
ECC5	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	
ECC6	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	
ECC7	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	
1. D18F2x250_dct[0][DataPatGenSel] = 10b D18F2x2[B4,B0,AC,A8]_dct[0] = {FFEE_DDCCh, BBAA_9988h, 7766_5544h, 3322_1100h}																									

Table 63. Configurable Data Pattern Circular Shift Example with 1 Address Target

DQ/ Beat	Write TgtA Cmd 0							Write TgtA Cmd 1								Write TgtA Cmd 2								...	
	Beat 0	Beat 1	Beat 2	Beat 3	Beat 4	Beat 5	Beat 6	Beat 7	Beat 8	Beat 9	Beat 10	Beat 11	Beat 12	Beat 13	Beat 14	Beat 15	Beat 16	Beat 17	Beat 18	Beat 19	Beat 20	Beat 21	Beat 22	Beat 23	...
0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	
1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
2	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
3	1	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	
4	0	0	1	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	
5	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	1	0	0	1	1	0	0	
6	0	1	1	0	0	1	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	
7	1	1	1	0	1	1	1	0	0	1	1	0	0	1	1	0	1	0	1	0	1	0	1	0	
8	0	0	0	1	0	0	0	1	1	1	1	0	1	1	1	0	0	1	1	0	0	1	1	0	
9	1	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	1	1	1	0	1	1	1	0	
10	0	1	0	1	0	1	0	1	1	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	
11	1	1	0	1	1	1	0	1	0	1	0	1	0	1	0	1	1	0	0	1	1	0	0	1	
12	0	0	1	1	0	0	1	1	1	1	0	1	1	1	0	1	0	1	0	1	0	1	0	1	
13	1	0	1	1	1	0	1	1	0	0	1	1	0	0	1	1	1	1	0	1	1	1	0	1	
14	0	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	0	1	1	0	0	1	1	
15	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	
...																									
ECC0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	
ECC1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
ECC2	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
ECC3	1	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	
ECC4	0	0	1	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	
ECC5	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	1	0	0	1	1	0	0	
ECC6	0	1	1	0	0	1	1	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	
ECC7	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	0	1	0	1	0	1	0	1	0	
1. D18F2x250_dct[0][DataPatGenSel] = 11b D18F2x2[B4,B0,AC,A8]_dct[0] = {FFEE_DDCCh, BBAA_9988h, 7766_5544h, 3322_1100h}																									

2.9.8.1.3.1 Static Data Pattern Override

Software is also able to use the bits of [D18F2x280_dct\[0\]](#), [D18F2x284_dct\[0\]](#), and [D18F2x288_dct\[0\]](#) to override the DCT pattern generator on a DQ basis. This can only be used in the [D18F2x250_dct\[0\]\[DataPatGenSel\]](#) = 10b mode. Software programs the following to enable the mode:

- Program [D18F2x288_dct\[0\]\[PatOvrVal\]](#) to the data value desired.
- Program [D18F2x280_dct\[0\]\[DQPatOvrEn\[31:0\]\]](#), [D18F2x284_dct\[0\]\[DQPatOvrEn\[63:32\]\]](#), and [D18F2x288_dct\[0\]\[EccPatOvrEn\]](#) to enable the override on the desired bit lanes.

Table 64. Data Pattern Override Example with 1 Address Target

DQ/ Beat	Write TgtA Cmd 0							Write TgtA Cmd 1								Write TgtA Cmd 2								..		
	Beat 0	Beat 1	Beat 2	Beat 3	Beat 4	Beat 5	Beat 6	Beat 7	Beat 8	Beat 9	Beat 10	Beat 11	Beat 12	Beat 13	Beat 14	Beat 15	Beat 16	Beat 17	Beat 18	Beat 19	Beat 20	Beat 21	Beat 22	Beat 23	..	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	
2	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	
3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	
4	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	
5	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
6	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	
9	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
10	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
11	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	1	
12	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	
13	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	
14	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
...																										
ECC0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ECC1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	
ECC2	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	
ECC3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	
ECC4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ECC5	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
ECC6	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	
ECC7	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	
1. D18F2x250_dct[0][DataPatGenSel] = 10b D18F2x2[B4,B0,AC,A8]_dct[0] = {FFEE_DDCCh, BBAA_9988h, 7766_5544h, 3322_1100h} D18F2x288_dct[0][PatOvrVal] = 0. D18F2x280_dct[0][DQPatOvrEn[31:0]] = 0x0000_0080. D18F2x284_dct[0][DQPatOvrEn[63:32]] = 0x0000_0000. D18F2x288_dct[0][EccPatOvrEn] = 0x10.																										

2.9.8.1.3.2 Xor Data Pattern Override

Software is also able to use the bits of D18F2x288_dct[0][XorPatOvr] to override the DCT pattern generator with the same XOR function for all byte lanes. This feature can only be used with select

D18F2x250_dct[0][DataPatGenSel] PRBS modes. Software programs the following to enable the mode:

- Program [D18F2x288_dct\[0\]\[XorPatOvr\]](#) to the data value of the XOR function desired.
 - Output data = IF (DQPatOvrEn) THEN PatOvrVal ELSE (DataPatGen ^ XorPatOvr) ENDIF.

2.9.8.1.4 Data Comparison

The DCT compares the incoming read data against the expected pattern sequence during pattern generation. BIOS may choose to continue command generation and accumulate errors or stop command generation on the first error occurrence by programming [D18F2x250_dct\[0\]\[StopOnErr\]](#).

Error information is reported via [D18F2x264_dct\[0\]](#), [D18F2x268_dct\[0\]](#), [D18F2x26C_dct\[0\]](#), [D18F2x294_dct\[0\]](#), [D18F2x298_dct\[0\]](#) and [D18F2x29C_dct\[0\]](#). Error information can be masked on per-bit basis by programming [D18F2x274_dct\[0\]](#), [D18F2x278_dct\[0\]](#), and [D18F2x27C_dct\[0\]](#).

BIOS resets the error information by programming [D18F2x250_dct\[0\]\[ResetAllErr\]](#)=1.

Error information is only valid in certain modes of [D18F2x250_dct\[0\]\[CmdType\]](#), [D18F2x250_dct\[0\]\[CmdTgt\]](#) and [D18F2x260_dct\[0\]\[CmdCount\]](#) and when using 64 byte aligned addresses in [D18F2x25\[8,4\]_dct\[0\]\[TgtAddress\]](#). Some modes require a series of writes to setup a DRAM data pattern. See [Table 65](#).

Table 65. Command Generation and Data Comparison

Commands	CmdType	Cmd Tgt	Maximum CmdCount ⁴
Read	000b	00b ¹	128
		01b ¹	256 ²
Write-Read	010b	00b	Infinite
		01b ³	256 ²

1. Requires setup writes to store a data pattern in DRAM. The write commands are generated using the same CmdTgt, CmdCount, and DataPrbsSeed settings.
2. D18F2x254[TgtAddress] != D18F2x258[TgtAddress].
3. Requires setup writes to store a data pattern in DRAM. The write commands are generated programming D18F2x254[TgtAddress] to the intended Target B, CmdTgt=00b, CmdCount to 1/2 of the intended command count, and the same DataPrbsSeed setting.
4. D18F2x250_dct[0][LsfrRollOver]=0. The maximum CmdCount is infinite for all modes listed if D18F2x250_dct[0][LsfrRollOver]=1.

2.9.8.1.4.1 Activate and Precharge Traffic Generation

The DCT generates ACT and PRE traffic in the available command bandwidth during a WR or RD sequence generated by [D18F2x250_dct\[0\]\[SendCmd\]](#) when [D18F2x250_dct\[0\]\[ActPchgGenEn\]](#)=1. This 16 command sequence repeats until the WR or RD initiated by SendCmd hits a stopping condition.

Software is able to adjust the command spacing and address sequence by programming [D18F2x28C_dct\[0\]\[CmdChipSelect\]](#), [D18F2x28C_dct\[0\]\[CmdAddress\[17:4\]\]](#), [D18F2x2B8_dct\[0\]\[ActPchgSeq\]](#), [D18F2x2B8_dct\[0\]\[ActPchgCmdMin\]](#), and [D18F2x2\[C0,BC\]_dct\[0\]](#).

The banks specified by [D18F2x2\[C0,BC\]_dct\[0\]](#) must be in the idle state and must not conflict with the banks used by the SendCmd WR or RD traffic stream. Software is responsible for the ACT/PRE protocol of the WR or RD targets initiated by SendCmd. On a stopping condition for the WR or RD traffic stream, software is responsible for returning all of the possibly open banks to the idle state.

- Example configuration for DRAM Training:
- [D18F2x250_dct\[0\]](#)[ActPchgGenEn, CmdTgt, CmdType] = { 1b, 1b, 0b}. // Tgt A&B, Reads
- [D18F2x28C_dct\[0\]](#)[CmdChipSelect] = CS of TgtA
- [D18F2x28C_dct\[0\]](#)[CmdAddress[17:4]] = desired upper row address bits.
 - Hardware places the sequence number in row address [3:0].
- [D18F2x2B8_dct\[0\]](#)[ActPchgSeq, ActPchgCmdMin] = {0F0Fh, Fh}.
- [D18F2x2BC_dct\[0\]](#) = 5432_ 5432h; // Banks 2,3,4,5
- [D18F2x2C0_dct\[0\]](#) = 7632_ 7632h; // Banks 2,3,6,7

2.9.8.1.5 BubbleCnt and CmdStreamLen Programming

BIOS programs [D18F2x25C_dct\[0\]](#)[BubbleCnt2, BubbleCnt, CmdStreamLen] to ensure proper channel command spacing in command generation mode.

For continuous pattern generation it is expected that BubbleCnt = 0. In other modes, BIOS programs BubbleCnt, BubbleCnt2, and CmdStreamLen greater than or equal to the relevant DRAM timing parameters shown below to prevent contention on the DRAM bus. In all cases, if the minimum BubbleCnt > 0 or CmdType = 010b then BIOS programs CmdStreamLen = 1.

Table 66. DDR3 Command Generation and BubbleCnt Programming

Commands	CmdType	CmdTgt	BubbleCnt	BubbleCnt2
Read-Read same CS	000b	0xb	D18F2x218_dct[0]_mp[1:0] [TrdrdSdSc] - 1; Exclude banned spacing: D18F2x218_dct[0]_mp[1:0] [TrdrdBan]	xh
Write-Write same CS	001b	0xb	D18F2x214_dct[0]_mp[1:0] [TwrrwrSdSc] - 1	xh
Write-Read same CS	010b	00b	D18F2x20C_dct[0]_mp[1:0] [Twtr] + D18F2x20C_dct[0]_mp[1:0] [Tcwl] + 4 - 1	D18F2x21C_dct[0]_mp[1:0] [TrwtTO] - 1
Read-Read different CS	000b	01b	D18F2x218_dct[0]_mp[1:0] [TrdrdSdDc] - 1; Exclude banned spacing: D18F2x218_dct[0]_mp[1:0] [TrdrdBan]	xh
Write-Write different CS	001b	01b	D18F2x214_dct[0]_mp[1:0] [TwrrwrSdDc] - 1	xh
Write-Read different CS	010b	01b	D18F2x218_dct[0]_mp[1:0] [Twrrrd] - 1	D18F2x21C_dct[0]_mp[1:0] [TrwtTO] - 1

Table 66. DDR3 Command Generation and BubbleCnt Programming

Commands	CmdType	CmdTgt	BubbleCnt	BubbleCnt2
Read-Read different DIMM	000b	01b	D18F2x218_dct[0]_mp[1:0][TrdrdDd] - 1; Exclude banned spacing: D18F2x218_dct[0]_mp[1:0][TrdrdBan]	xh
Write-Write different DIMM	001b	01b	D18F2x214_dct[0]_mp[1:0][TwrrwrDd] - 1	xh
Write-Read different DIMM	010b	01b	D18F2x218_dct[0]_mp[1:0][Twrrrd] - 1	D18F2x21C_dct[0]_mp[1:0][TrwtTO] - 1

2.9.9 Memory Interleaving Modes

The processor supports the following memory interleaving modes:

- Chip select: interleaves the physical address space over multiple DIMM ranks on a channel, as opposed to each DIMM owning single consecutive address spaces. See 2.9.9.1 [Chip Select Interleaving].

Table 67. Recommended Interleave Configurations

Interleaving Mode	Enabled	Disabled
Chip Select Interleaving	Number of chip selects installed on the channel is a power of two.	Requirements not satisfied.

2.9.9.1 Chip Select Interleaving

The chip select memory interleaving mode has the following requirements:

- The number of chip selects interleaved is a power of two.
- The chip selects are the same size and type.

A BIOS algorithm for programming D18F2x[5C:40]_dct[0] [DRAM CS Base Address] and D18F2x[6C:60]_dct[0] [DRAM CS Mask] in memory interleaving mode is as follows:

1. Program all DRAM CS Base Address and DRAM CS Mask registers using contiguous normalized address mapping.
2. For each enabled chip select, swap the corresponding BaseAddr[38:27] bits with the BaseAddr[21:11] bits as defined in Table 68.
3. For each enabled chip select, swap the corresponding AddrMask[38:27] bits with the AddrMask[21:11] bits as defined in Table 68.

Table 68. DDR3 Swapped Normalized Address Lines for CS Interleaving

Condition				Swapped Base Address and Address Mask bits	
DIMM Address Map ¹	CS Size	BankSwap ²	DctSelBankSwap ²	4 way CS interleaving	2 way CS interleaving
0001b	256MB	0	-	[29:28] and [17:16]	[28] and [16]
		1	1	[29:28] and [12:11]	[28] and [11]
		1	0	[29:28] and [13:12]	[28] and [12]
0010b	512MB	0	-	[30:29] and [17:16]	[29] and [16]
		1	1	[30:29] and [12:11]	[29] and [11]
		1	0	[30:29] and [13:12]	[29] and [12]
0101b	1GB	0	-	[31:30] and [17:16]	[30] and [16]
		1	1	[31:30] and [12:11]	[30] and [11]
		1	0	[31:30] and [13:12]	[30] and [12]
0111b	2GB	0	-	[32:31] and [17:16]	[31] and [16]
		1	1	[32:31] and [12:11]	[31] and [11]
		1	0	[32:31] and [13:12]	[31] and [12]
1010b	4GB	0	-	[33:32] and [17:16]	[32] and [16]
		1	1	[33:32] and [12:11]	[32] and [11]
		1	0	[33:32] and [13:12]	[32] and [12]
1011b	8GB	0	-	[34:33] and [18:17]	[33] and [17]
		1	1	[34:33] and [12:11]	[33] and [11]
		1	0	[34:33] and [13:12]	[33] and [12]
1. See D18F2x80_dct[0] [DRAM Bank Address Mapping].					
2. See D18F2xA8_dct[0] [BankSwap] and D18F2x114 [DctSel-BankSwap].					

2.9.10 Memory Hoisting

Memory hoisting reclaims the otherwise inaccessible DRAM that would naturally reside in memory regions used by MMIO. When memory hoisting is configured by BIOS, DRAM physical addresses are repositioned above the 4 GB address level in the address map. In operation, the physical addresses are remapped in hardware to the normalized addresses used by a DCT.

The region of DRAM that is hoisted is defined to be from [D18F1xF0](#)[DramHoleBase] to the 4 GB level. Hoisting is enabled by programming [D18F1xF0](#) [DRAM Hole Address] and configuring the DCTs per the equations in this section.

DramHoleSize is defined in order to simplify the following equations in this section and is calculated as follows:

- Define the DRAM hole region as $\text{DramHoleSize}[31:24] = 100\text{h} - \text{D18F1xF0}[\text{DramHoleBase}[31:24]]$.

2.9.10.1 DramHoleOffset Programming

$\text{D18F1xF0}[\text{DramHoleOffset}]$ is programmed to account for the addresses from $\text{D18F1xF0}[\text{DramHoleBase}]$ to 4 GB when it falls inside of a $\text{D18F1x2}[1,0][8,0][\text{DctBaseAddr}]$ and $\text{D18F1x2}[1,0][\text{C},4][\text{DctLimitAddr}]$ region. See Figure 5 as an example memory population.

- Program $\text{D18F1xF0}[\text{DramHoleOffset}[31:23]] = \{\text{DramHoleSize}[31:24], 0\text{b}\} + \{\text{DctBaseAddr}[31:27], 0000\text{b}\};$

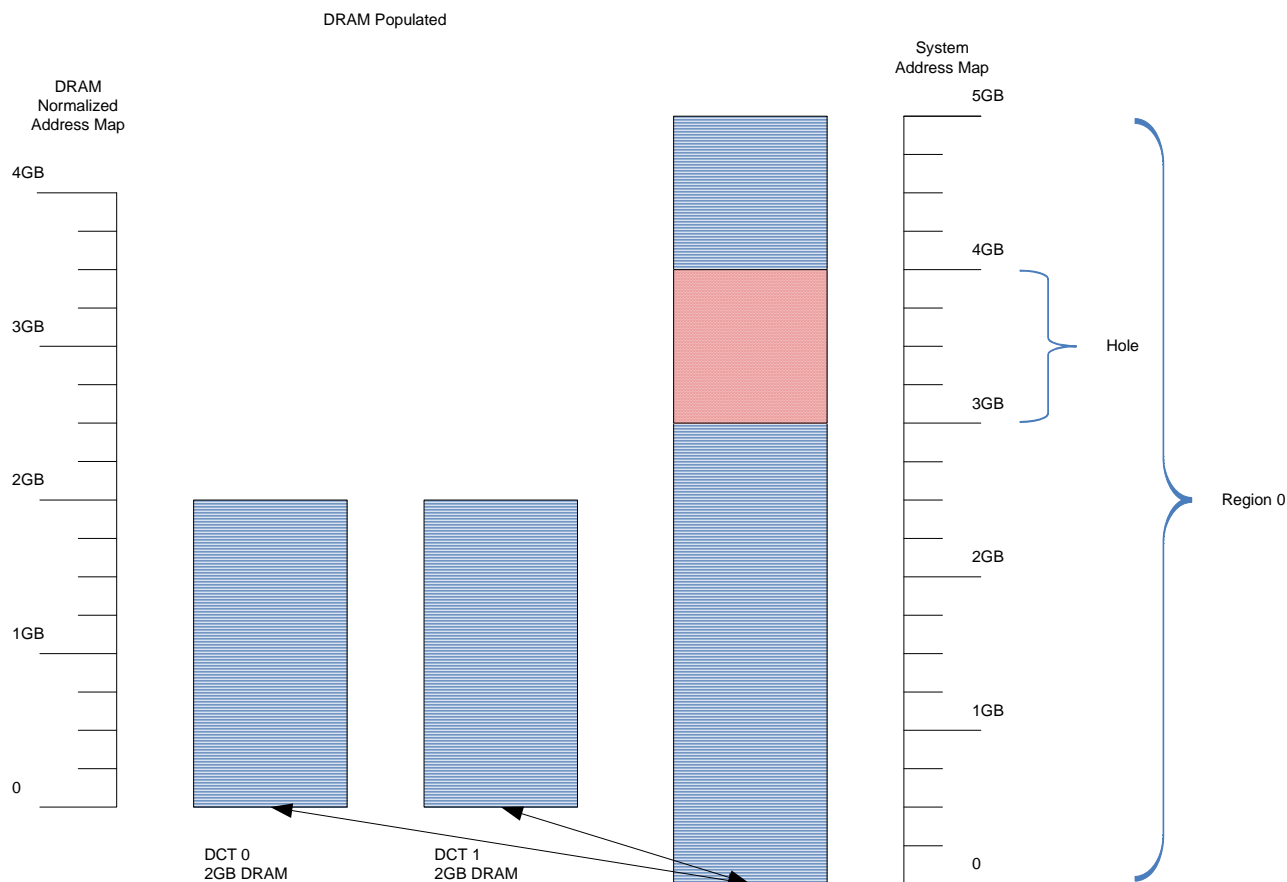


Figure 5: Memory Configuration with Memory Hole inside of Region

$\text{D18F1xF0}[\text{DramHoleOffset}]$ is unused when the memory hole falls outside of a region. Figure 6 shows an example memory population which uses two memory regions. Region 1 is configured to begin above the memory hole.

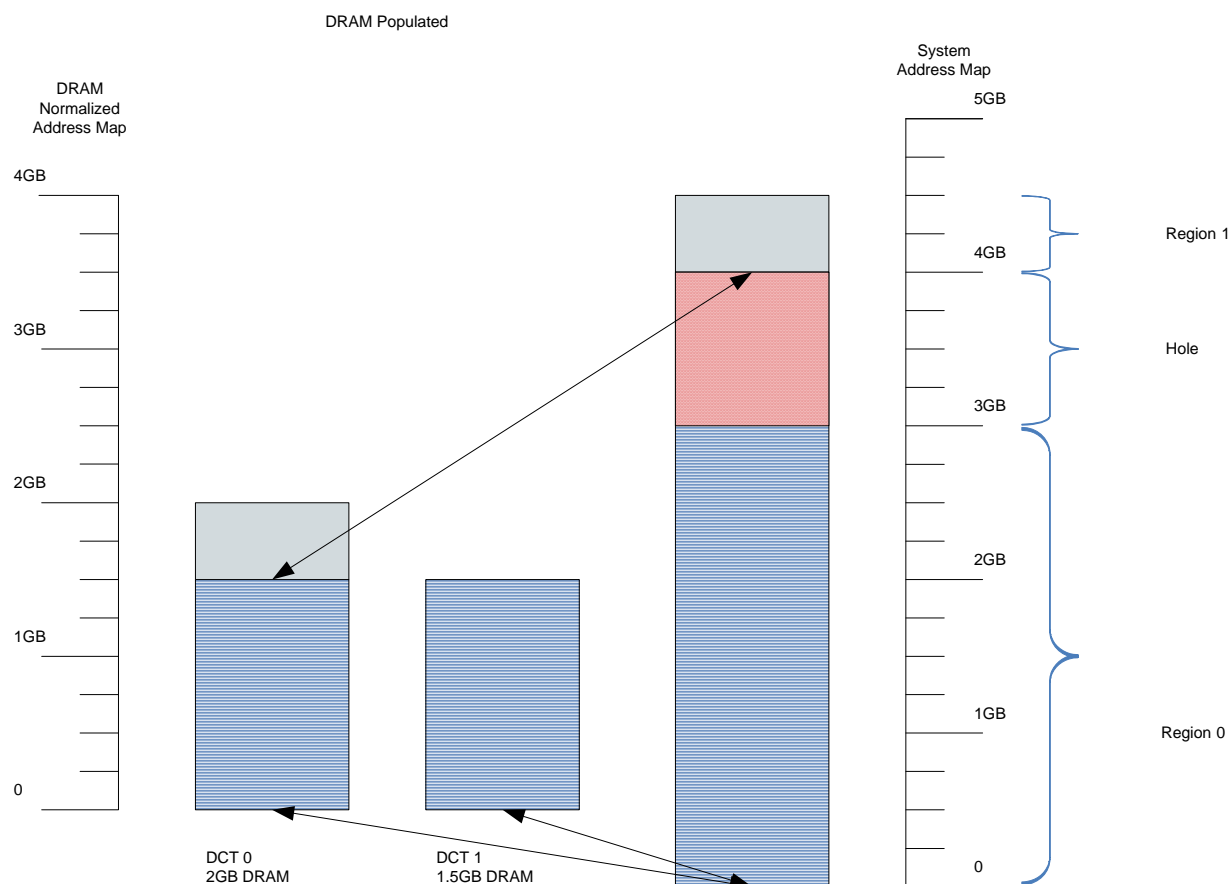


Figure 6: Memory Configuration with Memory Hole outside of Region

2.9.11 DRAM CC6/PC6 Storage

DRAM is used to hold the state information of cores entering the CC6 power management state. As part of the system setup if CC6 or PC6 is enabled, BIOS configures a special region of DRAM to hold the state information. In operation, hardware protects this region from general system accesses while allowing the cores access during C-state transitions.

2.9.11.1 Fixed Storage

The size of each special DRAM storage region is defined to be a fixed 16MB. BIOS configures the storage region at the top of the DRAM range, adjusts [D18F1x\[7:4\]\[C,4\]\[DramLimit\]](#) and the processor top of DRAM specified by [MSRC001_001A\[TOM\]](#) or [MSRC001_001D\[TOM2\]](#) downward accordingly. See [Table 69](#).

After finalizing the system DRAM configuration, BIOS must set [D18F2x118\[LockDramCfg\] = 1](#) to enable the hardware protection.

Table 69. Example storage region configuration

Node	DRAM Populated	D18F1x[17C:140,7C:40] [DramBase, DramLimit]	CC6 DRAM Range	D18F4x128 [CoreStateSa veDestNode]	D18F1x120[DramBaseAddr], D18F1x124[DramLimitAddr]
0	256 MB	0 MB, 240 MB - 1	240 MB, 256 MB - 1	0	0 MB, 256 MB - 1

2.9.12 DRAM On DIMM Thermal Management and Power Capping

Each DCT can throttle commands based on the state of the channel EVENT_L pin or when D18F2xA4[BwCapEn]=1. The EVENT_L pin is used for thermal management while D18F2xA4[BwCapEn] limits memory power independent of the thermal management solution.

The recommended BIOS configuration for the EVENT_L pin is as follows:

- BIOS may enable command throttling on a DRAM controller if the platform supports the EVENT_L pin by programming D18F2xA4[ODTSEn] = 1.
 - The recommended usage is for this pin to be connected to one or more JEDEC defined on DIMM temperature sensors. The DIMM SPD ROM indicates on DIMM temperature sensor support.
 - BIOS configures the temperature sensor(s) to assert EVENT_L pin active low when the trip point is exceeded and deassert EVENT_L when the temperature drops below the trip point minus the sensor defined hysteresis.
 - BIOS programs D18F2xA4[CmdThrottleMode] with the throttling mode to employ when the trip point has been exceeded.
 - The hardware enforces a refresh rate of 3.9 us while EVENT_L is asserted.
- BIOS configures D18F2x8C_dct[0][Tref] based on JEDEC defined temperature range options, as indicated by the DIMM SPD ROM. The two defined temperature ranges are normal (with a case temperature of 85 °C) and extended (with a case temperature of 95 °C).
 - If all DIMMs support the normal temperature range, or if normal and extended temperature range DIMMs are mixed, BIOS programs D18F2x8C_dct[0][Tref] to 7.8 us and D18F2xA4[ODTSEn] = 1. BIOS configures the temperature sensor trip point for all DIMMs according to the 85 °C case temperature specification.
 - If all DIMMs support the extended temperature range, BIOS has two options:
 - a. Follow the recommendation for normal temperature range DIMMs.
 - b. Program D18F2x8C_dct[0][Tref] = 3.9 us and configure the temperature sensor trip point for all DIMMs according to the 95 °C case temperature specification.
- At startup, the BIOS determines if the DRAMs are hot before enabling a DCT and delays for an amount of time to allow the devices to cool under the influence of the thermal solution. This is accomplished by checking the temperature status in the temperature sensor of each DIMM.
- The DCT latched status of the EVENT_L pin for can be read by system software in D18F2xAC [DRAM Controller Temperature Status].

The relationship between the DRAM case temperature, trip point, and EVENT_L pin sampling interval is outlined as follows:

- The trip point for each DIMM is ordinarily configured to the case temperature specification minus a guardband temperature for the DIMM.
- The temperature guardband is vendor defined and is used to account for sensor inaccuracy, EVENT_L pin sample interval, and platform thermal design.
- The sampling interval is vendor defined. It is expected to be approximately 1 second.

BIOS may enable bandwidth capping on a DRAM controller by setting [D18F2xA4\[BwCapEn\]](#) = 1 and programming [D18F2xA4\[BwCapCmdThrottleMode\]](#) with the throttling mode to employ. The DCT will employ the larger of the two throttling percentages as specified by [D18F2xA4\[BwCapCmdThrottleMode\]](#) and [D18F2xA4\[CmdThrottleMode\]](#) if the EVENT_L pin is asserted when both [D18F2xA4\[BwCapEn\]](#) = 1 and [D18F2xA4\[ODTSEn\]](#) = 1.

2.10 Thermal Functions

Thermal functions HTC, PROCHOT_L and THERMTRIP are intended to maintain processor temperature in a valid range by:

- Providing a signal to external circuitry for system thermal management like fan control.
- Lowering power consumption by switching to lower-performance P-state.
- Sending processor to the THERMTRIP state to prevent it from damage.

The processor thermal-related circuitry includes (1) the temperature calculation circuit (TCC) for determining the temperature of the processor and (2) logic that uses the temperature from the TCC.

2.10.1 The Tctl Temperature Scale

Tctl is a processor temperature control value used for processor thermal management. Tctl is accessible through [D18F3xA4\[CurTmp\]](#). Tctl is a temperature on its own scale aligned to the processors cooling requirements. Therefore Tctl does not represent a temperature which could be measured on the die or the case of the processor. Instead, it specifies the processor temperature relative to the maximum operating temperature, Tctl,max. Tctl,max is specified in the power and thermal data sheet. Tctl is defined as follows for all parts:

A: For $Tctl = Tctl_max$ to 255.875: the temperature of the part is $[Tctl - Tctl_max]$ over the maximum operating temperature. The processor may take corrective actions that affect performance, such as HTC, to support the return to Tctl range B.

B: For $Tctl = 0$ to $Tctl_max - 0.125$: the temperature of the part is $[Tctl_max - Tctl]$ under the maximum operating temperature.

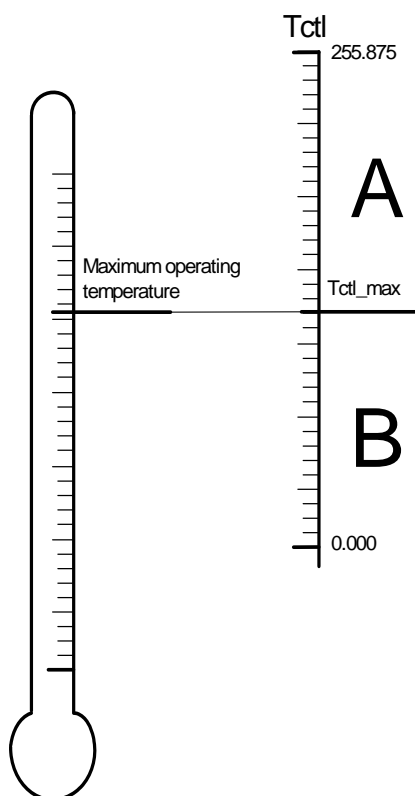


Figure 7: Tctl scale

2.10.2 Temperature Slew Rate Control

The temperature slew rate controls in [D18F3xA4](#) are used to filter the processor temperature provided in [D18F3xA4\[CurTmp\]](#). Separate controls are provided for increasing and decreasing temperatures. The latest measured temperature is referred to as Tctlm below.

If downward slew control is enabled ([D18F3xA4\[TmpSlewDnEn\]](#)), Tctl is not updated down unless Tctlm remains below Tctl for a time specified by [D18F3xA4\[PerStepTimeDn\]](#). If at any point before the timer expires Tctlm equals or exceeds Tctl, then the timer resets and Tctl is not updated. If the timer expires, then Tctl is reduced by 0.125. If downward slew control is disabled, then if Tctlm is less than Tctl, Tctl is immediately updated to Tctlm.

The upward slew control works similar to downward slew control except that if Tctlm exceeds Tctl by a value defined by [D18F3xA4\[TmpMaxDiffUp\]](#) then Tctl is immediately updated to Tctlm. Otherwise, Tctlm must remain above Tctl for time specified by [D18F3xA4\[PerStepTimeUp\]](#) before Tctl is incremented by 0.125.

2.10.3 Temperature-Driven Logic

The temperature calculated by the TCC is used by HTC, THERMTRIP, and PROCHOT_L.

2.10.3.1 PROCHOT_L and Hardware Thermal Control (HTC)

The processor *HTC-active state* is characterized by (1) the assertion of PROCHOT_L, (2) reduced power consumption, and (3) reduced performance. While in the HTC-active state, software should not change the following: All [D18F3x64](#) fields (except for HtcActSts and HtcEn), [MSRC001_001F\[DisProcHotPin\]](#). Any change to the previous list of fields when in the HTC-active state can result in undefined behavior. HTC status and control is provided through [D18F3x64](#).

The PROCHOT_L pin acts as both an input and as an open-drain output. As an output, PROCHOT_L is driven low to indicate that the HTC-active state has been entered due to an internal condition, as described by the following text. The minimum assertion and deassertion time for PROCHOT_L is 200 us with a minimum period of 2 ms.

While in the HTC-active state, the following power reduction actions are taken:

- CPU cores are limited to a P-state (specified by [D18F3x64\[HtcPstateLimit\]](#)); see 2.5.3 [CPU Power Management]
- The GPU may be placed in a low power state based on the state of [D18F5x178\[ProcHotToGnbEn\]](#)

The processor enters the HTC-active state if all of the following conditions are true:

- [D18F3xE8\[HtcCapable\]](#)=1
- [D18F3x64\[HtcEn\]](#)=1
- PWROK=1
- THERMTRIP_L=1

and any of the following conditions are true:

- Tctl is greater than or equal to the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)).
- PROCHOT_L=0

The processor exits the HTC-active state when all of the following are true:

- Tctl is less than the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)).
- Tctl has become less than the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)) minus the HTC hysteresis limit ([D18F3x64\[HtcHystLmt\]](#)) since being greater than or equal to the HTC temperature limit

(D18F3x64[HtcTmpLmt]).

- PROCHOT_L=1.

The default value of the HTC temperature threshold (Tctl_max) is specified in the Power and Thermal Data-sheet.

2.10.3.2 Software P-state Limit Control

D18F3x68 [Software P-state Limit] provides a software mechanism to limit the P-state MSRC001_0061[CurP-stateLimit]. See 2.5.3 [CPU Power Management].

2.10.3.3 THERMTRIP

If the processor supports the THERMTRIP state (as specified by D18F3xE4[ThermtpEn] or CPUID Fn8000_0007_EDX[TTP], which are the same) and the temperature approaches the point at which the processor may be damaged, the processor enters the THERMTRIP state. The THERMTRIP function is enabled after cold reset (after PWROK asserts and RESET_L deasserts). It remains enabled in all other processor states, except during warm reset (while RESET_L is asserted). The THERMTRIP state is characterized as follows:

- The THERMTRIP_L signal is asserted.
- Nearly all clocks are gated off to reduce dynamic power.
- A low-value VID is generated.
- The system is placed into the S5 ACPI state (power off).

A cold reset is required to exit the THERMTRIP state.

2.11 Root Complex

2.11.1 Overview

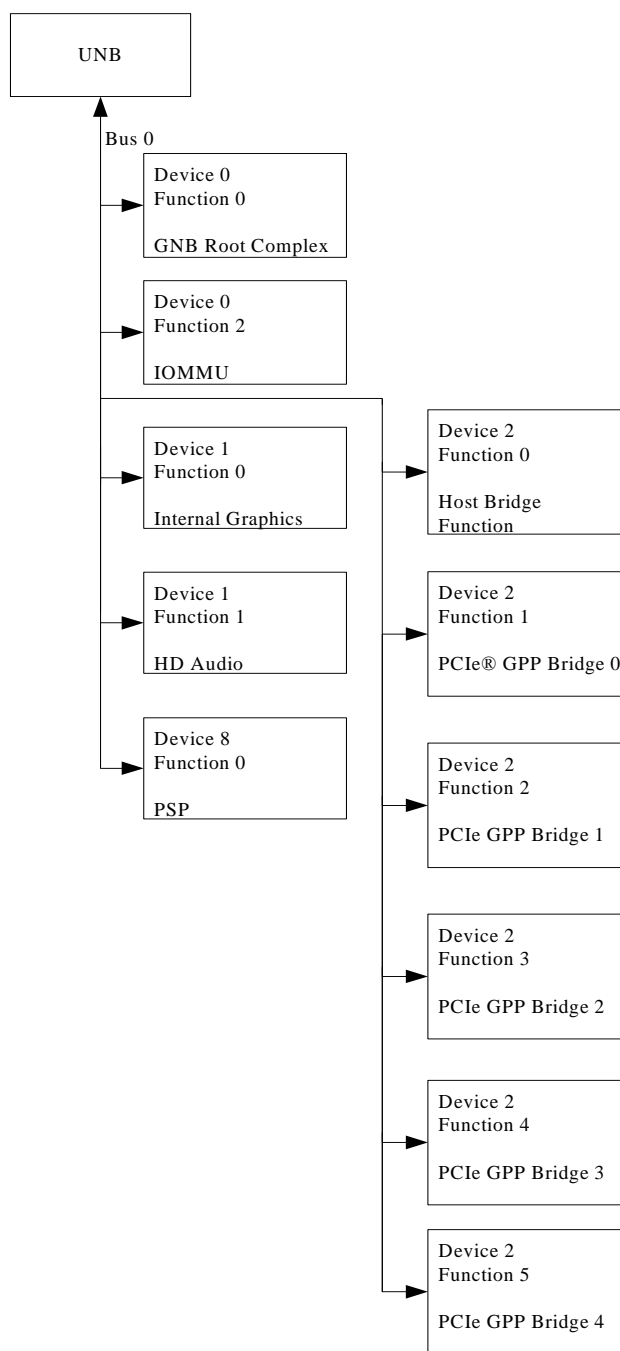


Figure 8: Root complex topology

2.11.2 Interrupt Routing

The GNB includes a fully programmable IOAPIC. The IOAPIC registers are accessed through the [D0F0xF8](#) index and [D0F0xFC](#) data pair registers using two back-to-back config cycles. PCI defined INTx interrupts for

each bridge are routed to IOAPIC pins via the bridge interrupt routing registers located at [D0F0xFC_x1\[4:0\]](#).

2.11.2.1 IOAPIC Configuration

The IOAPIC configuration is performed by the following sequence:

1. Set the base address for the memory mapped registers by programming [D0F0xFC_x01](#)[IoapicAddr] and [D0F0xFC_x02](#)[IoapicAddrUpper].
2. Enable IOAPIC by programming [D0F0xFC_x00](#)[IoapicEnable] = 1.
3. Only if the system is in PIC mode, program [D0F0xFC_x00](#)[IoapicSbFeatureEn] = 1. This bit should be programmed to 0 when the system is in APIC mode.

The IOAPIC has a total of 29 interrupt inputs. These inputs are as follows:

- 5 groups of PCIe interrupts each having a 4-bit external interrupt bus (INT A/B/C/D) and a 1-bit bridge interrupt, and
- a 4-bit external interrupt bus from GBIF.

The recommended interrupt routing and swizzling configuration is as shown in [Table 70](#).

Table 70: Recommended Interrupt Routing and Swizzling Configuration

Device	Register	Setting	Description
Dev2Fn1	D0F0xFC_x10 [BrExtIntrGrp]	0h	Map INT A/B/C/D to interrupt 0/1/2/3. Map bridge interrupt to interrupt 24.
	D0F0xFC_x10 [BrExtIntrSwz]	0h	
	D0F0xFC_x10 [BrIntIntrMap]	18h	
Dev2Fn2	D0F0xFC_x11 [BrExtIntrGrp]	1h	Map INT A/B/C/D to interrupt 4/5/6/7. Map bridge interrupt to interrupt 25.
	D0F0xFC_x11 [BrExtIntrSwz]	0h	
	D0F0xFC_x11 [BrIntIntrMap]	19h	
Dev2Fn3	D0F0xFC_x12 [BrExtIntrGrp]	2h	Map INT A/B/C/D to interrupt 8/9/10/11. Map bridge interrupt to interrupt 26.
	D0F0xFC_x12 [BrExtIntrSwz]	0h	
	D0F0xFC_x12 [BrIntIntrMap]	1Ah	
Dev2Fn4	D0F0xFC_x13 [BrExtIntrGrp]	3h	Map INT A/B/C/D to interrupt 12/13/14/15. Map bridge interrupt to interrupt 27.
	D0F0xFC_x13 [BrExtIntrSwz]	0h	
	D0F0xFC_x13 [BrIntIntrMap]	1Bh	
Dev2Fn5	D0F0xFC_x14 [BrExtIntrGrp]	4h	Map INT A/B/C/D to interrupt 16/17/18/19. Map bridge interrupt to interrupt 24.
	D0F0xFC_x14 [BrExtIntrSwz]	0h	
	D0F0xFC_x14 [BrIntIntrMap]	18h	
Dev8Fn0		4h	Map INT A/B/C/D to interrupt 18/19/16/17.
		2h	
GBIF	D0F0xFC_x0F [GBIFExtIntrGrp]	5h	Map INT A/B/C/D to interrupt 20/21/22/23.
	D0F0xFC_x0F [GBIFExtIntrSwz]	0h	

2.11.3 Links

2.11.3.1 Overview

There is one 5 x8 PCIe core with five configurable ports. These ports can be divided into 2 groups:

- Gfx: Contains 1 x4 port to create a 4-bit Gfx lane using the upper 4 lanes of the PCIe core.
- GPP: Contains upto 4 General Purpose Ports (GPP) using the lower 4 lanes of the PCIe core.

All PCIe links are capable of supporting Gen1/Gen2 data rates.

Gfx and GPP ports each have a Type 1 Virtual PCI-to-PCI bridge header in the PCI configuration space mapped to devices according to [Figure 8](#).

Each PCIe lane is assigned a unique lane ID that software uses to communicate configuration information to the SMU.

2.11.3.2 Link Configurations

Lanes of the Gfx ports can be assigned to IO links.

- For each 1x lane, program [D0F0xE4_x0130_0\[C:8\]04\[StrapBifMaxPayloadSupport\]=1h](#).

The following link configurations are supported for the GPP links:

Table 71: Supported General Purpose (GPP) Link Configurations

D0F0xE4		GPP Port Lane				
x0130_0080	x0110_0011	Lanes[7:4]	3	2	1	0
0000_0001h	0000_0300h	x4 Link (Gfx)	x4 Link			
0000_0002h	0000_0203h	x4 Link (Gfx)	x2 Link		x2 Link	
0000_0003h	0000_0201h	x4 Link (Gfx)	x1 Link	x1 Link	x2 Link	
0000_0004h	0000_0200h	x4 Link (Gfx)	x1 Link	x1 Link	x1 Link	x1 Link

2.11.4 Root Complex Configuration

2.11.4.1 LPC MMIO Requirements

To ensure proper operation of LPC generated DMA requests, the FCH must be configured to send processor generated MMIO writes that target the LPC bus to the FCH as non-posted writes. The MMIO address space of the LPC bus must not be included in the ranges specified by [D18F1x\[2CC:2A0,1CC:180,BC:80\] \[MMIO Base/Limit\]](#) and non-posted protocol for memory writes must be enabled using the following programming before LPC DMA transactions are initiated.

- Program [D0F0x98_x06\[UmiNpMemWrEn\]](#) = 1.

2.11.4.2 Configuration for non-FCH Bridges

BIOS should program the following in non-FCH bridges:

- Program [D0F0xCC_x01_ib\[15:11\]\[CrSEnable\]](#) = 1 for [D0F0xC8\[NbDevIndSel\]](#) = 11h-15h.
- Program [D0F0xCC_x01_ib\[15:11\]\[SetPowEn\]](#) = 1 for [D0F0xC8\[NbDevIndSel\]](#) = 11h-15h.

2.11.4.3 Link Configuration and Initialization

Link configuration and initialization is performed by the following sequence:

- [2.11.4.3.1 \[Link Configuration and Core Initialization\]](#)
- [2.11.4.3.2 \[Link Training\]](#)
- [2.11.4.5 \[Link Power Management\]](#)
- Lock link configuration registers.
 - Program [D0F0xE4_x0140_0010\[HwInitWrLock\]](#) = 1.

- Program `D0F0xE4_x00[HwInitWrLock]` = 1.

2.11.4.3.1 Link Configuration and Core Initialization

Link configuration is done on a per link basis. Lane reversal, IO link selection, and lane enablement is configured through this sequence.

Link configuration is done on a per link basis. Lane reversal, IO link selection, and lane enablement is configured through this sequence.

1. Place software-reset module into blocking mode:
 - A. Program `D0F0xE4_x0130_8062[ConfigXferMode]`=0.
 - B. Program `D0F0xE4_x0130_8062[BlockOnIdle]`=0.
2. If the link is an IO link, Program `D0F0xE4_x0140_0011[DynClkLatency]`=Fh.
3. Program `D0F0xE4_x0130_0080` per Table 71.
4. Program `D0F0xE4_x0130_802[4:1]` per Table 71.
5. Program `D0F0xE4_x0110_0010[RxDetectTxPwrMode]`=1.
6. Program `D0F0xE4_x0110_0010[Ln2ExitTime]`=000b.
7. Program `D0F0xE4_x0130_8013[MasterPciePllA, MasterPciePllB]` per Table 71.
8. Initiate core reconfiguration sequence:
 - A. Program `D0F0xE4_x0130_8062[ReconfigureEn]`=1.
 - B. Program `D0F0xE4_x0130_8060[Reconfigure]`=1.
 - C. Wait for `D0F0xE4_x0130_8060[Reconfigure]`==0.
 - D. Program `D0F0xE4_x0130_8062[ReconfigureEn]`=0.
9. Return software-reset module to non-blocking mode:
 - A. Program `D0F0xE4_x0130_8062[ConfigXferMode]`=1.
10. Program `D2F[5:1]xE4_xC1[StrapReverseLanes]` if necessary.
11. Program `D0F0xE4_x0110_0011` per Table 71.
12. For each lane that is not in use, program the corresponding `D0F0xE4_x0130_8029[LaneEnable]`=0.
13. Configure PIF parings:
 - A. Program `D0F0xE4_x0110_0011`=0000_0300h.

2.11.4.3.2 Link Training

Link training is performed on a per link basis. BIOS may train the links in parallel.

2.11.4.4 Miscellaneous Features

2.11.4.4.1 Lane Reversal

Normally, the lanes of each port are physically numbered from n-1 to 0 where n is the number of lanes assigned to the port. Physical lane numbering can be reversed according to the following methods:

- To reverse the physical lane numbering for a specific port, program `D2F[5:1]xE4_xC1[StrapReverseLanes]`=1.
- To reverse the physical lane numbering for all ports in the GPP or GFX interfaces, program `D0F0xE4_x0140_00C0[StrapReverseAll]`=1.

Note that logical port numbering is established during link training regardless of the physical lane numbering.

2.11.4.4.2 Link Speed Changes

Link speed changes can only occur on Gen2 capable links. To verify that Gen2 speeds are supported verify `D2F[5:1]x64[LinkSpeed]`==02h.

2.11.4.4.2.1 Autonomous Link Speed Changes

To enable autonomous speed changes on a per port basis:

1. Program `D2F[5:1]x88[TargetLinkSpeed]=2h`.
2. Program `D0F0xE4_x0130_0[C:8]03[StrapBifDeemphasisSel]=1`.
3. Program `D2F[5:1]xE4_xA4[LcGen2EnStrap]=1`.
4. Program `D2F[5:1]xE4_xC0[StrapAutoRcSpeedNegotiationDis]=0`.
5. Program `D2F[5:1]xE4_xA4[LcMultUpstreamAutoSpdChngEn]=1`.
6. Program `D2F[5:1]xE4_xA2[LcUpconfigureDis]=0`.

2.11.4.4.3 Deemphasis

Deemphasis strength can be changed on a per-port basis by programming `D2F[5:1]xE4_xB5[LcSelectDeemphasis]`.

2.11.4.5 Link Power Management

2.11.4.5.1 Link States

To enable support for L1 program `D2F[5:1]xE4_xA0[LcL1Inactivity]=6h`.

To enable support for L0s:

- Program `D2F[5:1]xE4_xA1[LcDontGotoL0sifL1Armed]=1`.
- Program `D2F[5:1]xE4_xA0[LcL0sInactivity]=9h`.

2.11.4.5.2 Dynamic Link-width Control

Dynamic link-width control is a power saving feature that reconfigures the link to run with fewer lanes. The inactive lanes are turned off to conserve power.

Each link can switch among widths of: x1, x2, x4, x8, and x16, up to the maximum port width.

The link width is controlled by the following mechanism:

- Up/Down Reconfiguration: The link is retrained according to the PCI Express specification.

The core has the capability to turn off the inactive lanes of trained links. To enable this feature program `D2F[5:1]xE4_xA2[LcDynLanesPwrState]=11b`.

2.11.4.6 Link Test and Debug Features

2.11.4.6.1 Compliance Mode

To enable Gen1 software compliance mode program `D2F[5:1]xE4_xC0[StrapForceCompliance]=1` for each port to be placed in compliance mode.

To enable Gen2 software compliance mode:

1. BIOS enables Gen2 capability by programming `D0F0xE4_x0140_00C1[StrapGen2Compliance]=1`.
2. Program `D2F[5:1]xE4_xA4[LcGen2EnStrap]=1`.
3. Program `D2F[5:1]x88[TargetLinkSpeed]=2h` for each port to be placed in compliance mode.
4. Program `D2F[5:1]x88[EnterCompliance]=1` for each port to be placed in compliance mode.

2.11.5 BIOS Timer

The root complex implements a 32-bit microsecond timer (see [D0F0xE4_x0130_80F0](#) and [D0F0xE4_x0130_80F1](#)) that the BIOS can use to accurately time wait operations between initialization steps.

To ensure that BIOS waits a minimum number of microseconds between steps BIOS should always wait for one microsecond more than the required minimum wait time.

2.11.6 PCIe® Client Interface Control

This interface is accessed through the indexed space registers located at [D0F2xF8](#) within the [Device 0 Function 2 \(IOMMU\) Configuration Registers](#).

BIOS should perform the following steps to initialize the interface:

1. Program [D0F0x64_x0D](#)[PciDev0Fn2RegEn] = 1h.
2. Program credits for the BIF client as follows:
 - A. Program [D0F2xFC_x32_L1i\[2\]](#)[DmaNpHaltDis] = 1h.
 - B. Program [D0F2xFC_x32_L1i\[2\]](#)[DmaBufCredits] = 20h.
 - C. Program [D0F2xFC_x32_L1i\[2\]](#)[DmaBufMaxNpCred] = 20h.
3. Program credits for the INTGEN client as follows:
 - A. Program [D0F2xFC_x32_L1i\[3\]](#)[DmaNpHaltDis] = 1h.
 - B. Program [D0F2xFC_x32_L1i\[3\]](#)[DmaBufCredits] = 4h.
 - C. Program [D0F2xFC_x32_L1i\[3\]](#)[DmaBufMaxNpCred] = 4h.
4. Program credits for the SPG client as follows:
 - A. Program [D0F2xFC_x32_L1i\[4\]](#)[DmaBufCredits] = 8h.
 - B. Program [D0F2xFC_x32_L1i\[4\]](#)[DmaBufMaxNpCred] = 7h.
5. Program credits for the SBG client as follows:
 - A. Program [D0F2xFC_x32_L1i\[1\]](#)[DmaBufCredits] = 8h.
 - B. Program [D0F2xFC_x32_L1i\[1\]](#)[DmaBufMaxNpCred] = 7h.
6. Program clock gating as follows:
 - A. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1DmaClkgateEn] = 1h.
 - B. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1CacheClkgateEn] = 1h.
 - C. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1CpslvClkgateEn] = 1h.
 - D. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1DmaInputClkgateEn] = 1h.
 - E. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1PerfClkgateEn] = 1h.
 - F. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1MemoryClkgateEn] = 1h.
 - G. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1RegClkgateEn] = 1h.
 - H. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1HostreqClkgateEn] = 1h.
 - I. Program [D0F2xFC_x33_L1i\[4:0\]](#)[L1L2ClkgateEn] = 1h.
 - J. Program [D0F2xF4_x33](#)[CKGateL2ARegsDisable] = 0h.
 - K. Program [D0F2xF4_x33](#)[CKGateL2ADynamicDisable] = 0h.
 - L. Program [D0F2xF4_x33](#)[CKGateL2ACacheDisable] = 0h.
 - M. Program [D0F2xF4_x90](#)[CKGateL2BRegsDisable] = 0h.
 - N. Program [D0F2xF4_x90](#)[CKGateL2BDynamicDisable] = 0h.
 - O. Program [D0F2xF4_x90](#)[CKGateL2BMiscDisable] = 0h.
7. Program [D0F0x64_x0D](#)[PciDev0Fn2RegEn] = 0h.

2.12 IOMMU

The processor includes an IOMMU revision 2. See the *AMD I/O Virtualization Technology (IOMMU) Specification*.

2.12.1 IOMMU Configuration Space

The IOMMU configuration space consists of the following four groups:

- PCI Configuration space. See [3.4 \[Device 0 Function 2 \(IOMMU\) Configuration Registers\]](#).
- IOMMU Memory Mapped Register space. See [3.15 \[IOMMU Memory Mapped Registers\]](#).
- IOMMU L1 Indexed space accessed through [D0F2xF8 \[IOMMU L1 Config Index\]](#).
- IOMMU L2 Indexed space accessed through [D0F2xF0 \[IOMMU L2 Config Index\]](#).

2.12.2 IOMMU Initialization

BIOS should perform the following steps to initialize the IOMMU:

1. Program [D0F0x64_x0D\[PciDev0Fn2RegEn\]](#) = 1h.
2. Program [D0F2x44 \[IOMMU Base Address Low\]](#) and [D0F2x48 \[IOMMU Base Address High\]](#) to allocate a 512K region of MMIO space for IOMMU memory mapped registers. This region of MMIO space is reserved for IOMMU and BIOS must not allocate it for use by system software.
3. Program [D0F2x50\[IommuHtAtsResv\]](#) = 0h.
4. Program [D0F2x44\[IommuEnable\]](#)=1.
5. Program [D0F2x80\[PrefSupW\]](#)=0.
6. Program [D2F\[5:1\]xE4_xC1\[StrapExtendedFmtSupported\]](#)=1 and [D2F\[5:1\]xE4_xC1\[StrapE2EPrefixEn\]](#)=1.
7. Program [IOMMUx18\[Isoc\]](#)=1h if processors support isochronous channel.
8. Program the registers with BIOS recommendations in L1 ([D0F2xFC](#)) and L2 ([D0F2xF4](#)) indexed space. See [2.11.6 \[PCIe Client Interface Control\]](#).
9. Check if any PCIe devices in the system support the Phantom Function. For each PCIe core that none of its connected device advertising support for the Phantom Function, program [D0F2xFC_x07_L1i\[4:0\]\[0\]](#)=1 for the L1 corresponding to that PCIe core.
10. If a PCIe port is hot-plug capable, then program [D0F2xFC_x07_L1i\[4:0\]\[0\]](#)=0 for the L1 corresponding to the PCIe core.
11. If at least one PCIe to PCI-x bridge exists on a PCIe port or a HotPlug capable PCIe slot is present on a PCIe port then program [D0F2xFC_x0D_L1i\[4:0\]\[VOQPortBits\]](#)=111b for the L1 corresponding to the particular PCIe core.
12. Program the location of the SB into [D0F2xF4_x49 \[L2_SB_LOCATION\]](#). The program value is required to match the value programmed in [D0F0x64_x1F \[FCH Location\]](#).
13. Program the port location of the SB into [D0F2xFC_x09_L1i\[4:0\] \[L1_SB_LOCATION\]](#) for the L1 corresponding to the iFCH or the PCIe core which FCH is located. Leave register at default value for all L1s corresponding to other PCIe cores.

2.12.2.1 IOMMU L1 Initialization

BIOS should perform the following steps to initialize the IOMMU L1:

1. Program [D0F2xFC_x0C_L1i\[4:0\]\[L1 VirtOrderQueues\]](#)=4h.
2. Program [D0F2xFC_x32_L1i\[4:0\]\[AtsMultipleRespEn\]](#)=1h.
3. Program [D0F2xFC_x32_L1i\[4:0\]\[AtsMultipleL1toL2En\]](#)=1h.
4. Program [D0F2xFC_x32_L1i\[4:0\]\[TimeoutPulseExtEn\]](#)=1h.

5. Program `D0F2xFC_x07_L1i[4:0][AtsPhysPageOverlapDis]=1h`.
6. Program `D0F2xFC_x07_L1i[4:0][AtsSeqNumEn]=1h`.
7. Program `D0F2xFC_x07_L1i[4:0][SpecReqFilterEn]=1h`.
8. Program `D0F2xFC_x07_L1i[4:0][L1NwEn]=1h`.

2.12.2.2 IOMMU L2 Initialization

BIOS should perform the following steps to initialize the IOMMU L2:

1. Program `D0F2xF4_x10[DTCInvalidationSel]=2h`.
2. Program `D0F2xF4_x14[ITCInvalidationSel]=2h`.
3. Program `D0F2xF4_x18[PTCAInvalidationSel]=2h`.
4. Program `D0F2xF4_x50[PDCInvalidationSel]=2h`.
5. Program `D0F2xF4_x80[ERRRuleLock0]=1h`.
6. Program `D0F2xF4_x30[ERRRuleLock1]=1h`.
7. Program `D0F2xF4_x34[L2aregHostPgsize]=2h`.
8. Program `D0F2xF4_x34[L2aregGstPgsize]=2h`.
9. Program `D0F2xF4_x94[L2bregHostPgsize]=2h`.
10. Program `D0F2xF4_x94[L2bregGstPgsize]=2h`.
11. Program `D0F2xF4_x4C[GstPartialPtcCntl]=3h`.
12. If no internal gfx, program `D0F2xF4_x57[L1ImuIntGfxDis]=1h`.
13. If no external gfx, program `D0F2xF4_x57[0]=1h`.
14. Program `D0F2xF4_x47[TwAtomicFilterEn]=1h`.
15. Program `D0F2xF4_x47[TwNwEn]=1h`.
16. Program `D0F2xF4_x56[CPFlushOnWait]=1h`.
17. Program `D0F2xF4_x56[CPFlushOnInv]=0h`.
18. Program `D0F2xF4_x53[L2bUpdateFilterBypass]=0h`.
19. Program `D0F2xF4_x22[L2aUpdateFilterBypass]=0h`.

2.12.2.3 IOMMU SMI Filtering

In order to ensure system management interrupts come from valid peripheral sources, the IOMMU supports an SMI filter (`IOMMUx30[SmiFSup]==01b`). SMI interrupts are filtered according to the values programmed in the SMI filter registers. The registers specify what sources are allowed to send SMI interrupts.

`IOMMUx30[SmiFRC]` indicates the number of SMI filter registers available.

The BIOS should set up the SMI filter registers and lock them. These setting will take effect when system software enables the IOMMU and enables SMI filtering. BIOS should perform the following steps to set up SMI filtering:

1. Choose an SMI filter register from the available set described in `IOMMUx30[SmiFRC]`. Select one register for each SMI source.
2. Program selected SMI filter register to the Device ID of the peripheral issuing the SMI interrupts via `IOMMUx[78,70,68,60][SMIDid]`. Program one register for each SMI source.
3. Program selected SMI filter register to be valid via `IOMMUx[78,70,68,60][SMIDV]`. Program one register for each SMI source.
4. Program selected SMI filter register to be locked via `IOMMUx[78,70,68,60][SMIFlock]`. Program one register for each SMI source.

2.13 System Management Unit (SMU)

The system management unit (SMU) is a subcomponent of the northbridge that is responsible for a variety of system and power management tasks during boot and runtime. The SMU contains a microcontroller to assist with many of these tasks.

2.13.1 Software Interrupts

The microcontroller can be interrupted to cause it to perform several initialization and runtime tasks. BIOS and ACPI methods can interrupt the SMU to request a specific action using the following sequence:

1. If a service request requires an argument, program `D0F0xBC_xC210_003C`[Argument] with the desired argument.
1. Wait for `D0F0xBC_xC210_0004`[IntDone]==1.
2. Program `D0F0xBC_xC210_0000`[ServiceIndex] to the desired service index and toggle. This may be done in a single write.
3. Wait for `D0F0xBC_xC210_0004`[IntAck]==1.

After performing the steps above, software may continue execution before the interrupt has been serviced. However, software should not rely on the results of the interrupt until the service is complete (see `D0F0xBC_xC210_0004`[IntDone]). Interrupting the SMU with a service index that does not exist results in undefined behavior.

Table 72: SMU Software Interrupts

Service Index	Notes
1Eh	Description: BIOSMC_MSG_LCLK_DPM_ENABLE . Enables LCLK DPM. See 2.5.6.1.3 [LCLK DPM].
	Input: <code>D0F0xBC_x3FDC8</code>
	Output: None.
3Ah	Description: BIOSMC_MSG_VDDNB_REQUEST . Request VDDNB voltage.
	Input: Program argument to desired voltage (encoded in mV with two fraction bits). Values outside <code>D18F5x17C</code> [MaxVid, MinVid] range are invalid and result in undefined behavior. <ul style="list-style-type: none"> • <code>D0F0xBC_xC210_003C</code>[Argument] = (Desired Voltage in mV) * 4.
	Output: None.
43h	Description: BIOSMC_MSG_NBDPM_Enable . Enables NB P-state Adjustments.
	Input: <code>D0F0xBC_x3F9E8</code>
	Output: <code>D0F0xBC_x3F9EC</code>

2.14 Platform Security Processor (PSP)

The PSP is a standalone complex within AMD Family 16h Models 30h-3Fh processors that is responsible for creating, monitoring and maintaining the security environment. Its functions include managing the boot process, initializing various security related mechanisms, and monitoring the system for any suspicious activity or events and implementing an appropriate response.

The PSP consists of an ARM microcontroller, cryptographic coprocessor (CCP), local memory, local registers,

and interfaces to interact with the system memory, IO, and configuration registers. The PSP also houses the EMC (Environment Management Control) block, which performs environmental and security checking to ensure that the processor is operating within the defined limits.

2.14.1 PSP Interrupts

There are several sources of interrupts to and from the PSP. [Table 73](#) describes the PSP interrupt sources.

Table 73: PSP Interrupt Sources

Interrupt Source	Description	Direction
CPU cores	Hypervisor mode.	To PSP
	Guest mode.	
CPU messages	CPU message registers.	
FCH messages	FCH message registers through I2C interface.	
APIC	UNB APIC controller.	
GPIO	GPIO pins.	
GIO	Side band signal. Fence violation detection.	
PSP	CPU message registers.	From PSP
	I2C Master.	

The PSP processor can generate interrupts to the CPU using PCI MSI compliant messages. There are two ways to generate an MSI to a CPU. The PSP can generate the MSI message directly via a posted write to the reserved address space of the processor, which is decoded by the UNB and presented to the APIC as an interrupt; or, the PSP uses a sideband signal to the GIO indicating a request for an interrupt and the GIO composes the MSI message using the address/format specified by the SMU's config registers.

The CPU can raise interrupts to the PSP as well. This is done via a PSP CPU mailbox mechanism where a CSR register is set allowing each CPU to raise an interrupt to the PSP.

The PSP also actively filters external interrupts using a fencing logic as a secondary level of protection after the IOMMU. Vectored interrupts may be blocked on a per-vector basis. Errors are logged in the the ORB status registers when an interrupt is blocked by the fence.

2.14.1.1 I2C, JTAG Mailbox Mechanism

There are mechanisms within the processor to enable authentication of APML and JTAG accesses to the processor by the PSP. This is facilitated by the presence of two mailboxes whose function is to capture these commands at the slave controller and inform the PSP of their presence. The PSP will authenticate and verify these commands before allowing them to complete. These mechanisms are completely transparent to the system users as their method of APML or JTAG accesses remain unchanged from earlier products.

2.14.2 Programming PSP Host Address Mapping

The PSP exposes standard PCI BARs to request/claim MMIO resources.

2.15 Graphics Processor (GPU)

The APU contains an integrated DX11 compliant graphics processor.

2.15.1 Graphics Memory Controller (GMC)

The graphics memory controller is responsible for servicing memory requests from the different blocks within the GPU and forwarding routing them to the appropriate interface. The GMC is also responsible for translating GPU virtual address to GPU physical addresses and for translating GPU physical addresses to system addresses.

2.15.2 Frame Buffer (FB)

The frame buffer is defined as the portion of system memory dedicated for GPU use.

Table 74: Recommended Frame Buffer Configurations

System Memory Size	Frame Buffer Size
< 2 GB	128 MB
>= 2 GB & < 4 GB	256 MB
>= 4 GB & < 6 GB	512 MB
>= 6 GB	1 GB

2.16 RAS Features

2.16.1 Machine Check Architecture

The processor contains logic and registers to detect, log, and correct errors in the data or control paths in each core and the Northbridge. The Machine Check Architecture (MCA) defines the facilities by which processor and system hardware errors are logged and reported to system software. This allows system software to perform a strategic role in recovery from and diagnosis of hardware errors.

Refer to the AMD64 Architecture Programmer's Manual for an architectural overview and methods for determining the processor's level of MCA support. See [1.2 \[Reference Documents\]](#).

The ability of hardware to generate a machine check exception upon an error is indicated by [CPUID Fn0000_0001_EDX\[MCE\]](#) or [CPUID Fn8000_0001_EDX\[MCE\]](#).

2.16.1.1 Machine Check Registers

[CPUID Fn0000_0001_EDX\[MCA\]](#) or [CPUID Fn8000_0001_EDX\[MCA\]](#) indicates the presence of the following machine check registers:

- [MSR0000_0179 \[Global Machine Check Capabilities \(MCG_CAP\)\]](#)
 - Reports how many machine check register banks are supported.
- [MSR0000_017A \[Global Machine Check Status \(MCG_STAT\)\]](#)
 - Provides basic information about processor state after the occurrence of a machine check error.
- [MSR0000_017B \[Global Machine Check Exception Reporting Control \(MCG_CTL\)\]](#)
 - Used by software to enable or disable the logging and reporting of machine check errors in the error-reporting banks.

The error-reporting machine check register banks supported in this processor are:

- MC0: Data cache (DC).
- MC1: Instruction cache (IC).
- MC2: Bus unit (BU), including L2 cache.
- MC3: Reserved.
- MC4: Northbridge (NB), including the IO link. These MSRs are also accessible from configuration space. There is only one NB error-reporting bank, independent of the number of cores.
- MC5: Fixed-issue reorder buffer (FR) machine check registers.
- The register types within each bank are:
 - [MCi_CTL](#), Machine Check Control: Enables error reporting via machine check exception. The [MCi_CTL](#) register in each bank must be enabled by the corresponding enable bit in [MCG_CTL \(MSR0000_017B\)](#).
 - [MCi_STATUS](#), Machine Check Status: Logs information associated with errors.
 - [MCi_ADDR](#), Machine Check Address: Logs address information associated with errors.
 - [MCi_MISC](#), Machine Check Miscellaneous: Log miscellaneous information associated with errors, as defined by each error type.
 - [MCi_CTL_MASK](#), Machine Check Control Mask: Inhibit detection of an error source unless otherwise specified.

The following table identifies the registers associated with each error-reporting machine check register bank:

Table 75: MCA register cross-reference table

Register Bank (MCi)	MCA Register				
	CTL	STATUS	ADDR	MISC	CTL_MASK
MC0	MSR0000_0400	MSR0000_0401	MSR0000_0402	MSR0000_0403	MSRC001_0044
MC1	MSR0000_0404	MSR0000_0405	MSR0000_0406	MSR0000_0407	MSRC001_0045
MC2	MSR0000_0408	MSR0000_0409	MSR0000_040A	MSR0000_040B	MSRC001_0046
MC3	MSR0000_040C	MSR0000_040D	MSR0000_040E	MSR0000_040F	MSRC001_0047
MC4	MSR0000_0410	MSR0000_0411	MSR0000_0412	MSR0000_0413	MSRC001_0048
MC5	MSR0000_0414	MSR0000_0415	MSR0000_0416	MSR0000_0417	MSRC001_0049

Corrected, deferred, and uncorrected errors are logged in MCi_STATUS and MCi_ADDR as they occur. Uncorrected errors that are enabled in MCi_CTL result in a Machine Check exception.

Each MCi_CTL register must be enabled by the corresponding enable bit in [MSR0000_017B \[Global Machine Check Exception Reporting Control \(MCG_CTL\)\]](#).

MCi_CTL_MASK allow BIOS to mask the presence of any error source from software for test and debug. When error sources are masked, it is as if the error was not detected. Such masking consequently prevents error responses and actions.

Each MCA bank implements a number of machine check miscellaneous registers, denoted as MCi_MISCj, where j goes from 0 to a maximum of 8. If there is more than one MCi_MISC register in a given bank, a non-zero value in MCi_MISC0[BlkPtr] points to the contiguous block of additional registers.

The presence of valid information in the first MISC register in the bank (MCi_MISC0) is indicated by MCi_STATUS[MiscV]. The presence of valid information in additional implemented MISC registers is indicated by MCi_MISCj[Val] in the target register.

2.16.1.2 Machine Check Errors

The classes of machine check errors are, in priority order from highest to lowest:

- Uncorrected
- Deferred
- Corrected

Uncorrected errors cannot be corrected by hardware and may cause loss of data, corruption of processor state, or both. Uncorrected errors update the status and address registers if not masked from logging in MCi_CTL_MASK. Information in the status and address registers from a previously logged lower priority error is overwritten. Previously logged errors of the same priority are not overwritten. Uncorrected errors that are enabled in MCi_CTL result in reporting to software via machine check exceptions. If an uncorrected error is masked from logging, the error is ignored by hardware (exceptions are noted in the register definitions). If an uncorrected error is disabled from reporting, containment of the error and logging/reporting of subsequent errors may be affected. Therefore, enable reporting of unmasked uncorrected errors for normal operation. Disable reporting of uncorrected errors only for debug purposes.

Deferred errors are errors that cannot be corrected by hardware, but do not cause an immediate interruption in

program flow, loss of data integrity, or corruption of processor state. These errors indicate that data has been corrupted but not consumed; no exception is generated because the data has not been referenced by a core or an IO link. Hardware writes information to the status and address registers in the corresponding bank that identifies the source of the error if deferred errors are enabled for logging. If there is information in the status and address registers from a previously logged lower priority error, it is overwritten. Previously logged errors of the same or higher priority are not overwritten. Deferred errors are not reported via machine check exceptions; they can be seen by polling the MCI_STATUS registers.

Corrected errors are those which have been corrected by hardware and cause no loss of data or corruption of processor state. Hardware writes the status and address registers in the corresponding register bank with information that identifies the source of the error if they are enabled for logging. Corrected errors are not reported via machine check exceptions. Some corrected errors may be reported to software via error thresholding (see [2.16.1.7 \[Error Thresholding\]](#)).

The implications of these categories of errors are:

1. Uncorrected error; hardware did not deal with the problem.
 - Operationally (error handling), action required, because program flow is affected.
 - Diagnostically (fault management), software may collect information to determine if any components should be de-configured or serviced.
2. Deferred error; hardware partially dealt with the problem via containment.
 - Operationally, action optional, because program flow has not been affected. However, steps may be taken by software to prevent access to the data in error.
 - Diagnostically, software may collect information to determine if any components should be de-configured or serviced.
3. Corrected error; hardware dealt with the problem.
 - Operationally, no action required, because program flow is unaffected.
 - Diagnostically, software may collect information to determine if any components should be de-configured or serviced.

Machine check conditions can be simulated to aid in debugging machine check handlers. See [2.16.3 \[Error Injection and Simulation\]](#) for more detail.

2.16.1.3 Error Detection, Action, Logging, and Reporting

Error detection is controlled by the MASK registers:

- Error detection for MCA controlled errors is enabled if not masked by MCI_CTL_MASK (see [Table 75 \[MCA register cross-reference table\]](#)).
- Error masking is performed regardless of MCA bank enablement in MCG_CTL (MSR0000_017B).

Error action refers to the hardware response to an error, aside from logging and reporting. Enablement of error action for each error is enumerated in the EAC (Error Action Condition) column of the error descriptions tables as follows:

- D: Detected. The error action is taken if the error is detected (i.e., not masked). These actions occur regardless of whether the MCA bank is enabled in MCG_CTL.
- E: Enabled. The error action is taken if the error is detected and the bank is enabled in MCG_CTL.

Error logging refers to the storing of information in the status registers, and is enabled if all of the following are true:

- Error detection is enabled.
- The MCA bank is enabled in MCG_CTL.

Error reporting refers to active notification of errors to software via machine check exceptions, and is enabled if all of the following are true:

- Error logging is enabled.
- The corresponding enable bit for the error in `MCi_CTL` is set to 1.

A machine check exception will be generated if all the following are true:

- The error is uncorrected.
- The error is enabled for reporting.
- `CR4.MCE` is enabled.

Notes:

1. If `CR4.MCE` is clear, an error configured to cause a machine check exception will cause a shutdown.
2. If error reporting is disabled, the setting of `CR4.MCE` has no effect.
3. If an uncorrected error is disabled from reporting, containment of the error and logging/reporting of subsequent errors may be affected. Therefore, unmasked uncorrected errors should be enabled for reporting for normal operation. Uncorrected errors should only be disabled from reporting for debug purposes.
4. Errors not associated with a specific core are reflected to core 0 of the compute unit. The error description tables identify which errors are associated or not associated with a specific core of the compute unit.

Throughout the MCA register descriptions, the terms “enabled” and “disabled” generally refer to reporting, and the terms “masked” and “unmasked” generally refer to logging, unless otherwise noted.

Some logged errors increment a counter in `MCi_MISC`, which may trigger an interrupt (see [2.16.1.7 \[Error Thresholding\]](#)). Although no machine check exception will be generated, these notifications can be viewed as “correctable machine check interrupts”.

For debug observability only, `D18F3x180[ConvertUnCorToCorErrEn]` can be used to log NB uncorrected errors as corrected errors.

2.16.1.3.1 MCA conditions that cause Shutdown

The following architectural conditions cause the processor to enter the Shutdown state; see section “Machine-Check Errors” in APM volume 2 for more detail; see [1.2 \[Reference Documents\]](#):

- Attempting to generate an MCE when machine check reporting is disabled at the system level (`CR4.MCE=0`).
- Attempting to generate an MCE when a machine check is in progress on the same core (`MSR0000_017A[MCIP]=1`).

The following non-architectural conditions cause the processor to enter the Shutdown state:

- On MCA interrupts, if two or more uncorrected errors occur across MCA banks.

2.16.1.3.2 Error Logging During Overflow

An error to be logged when the status register contains valid data can result in an overflow condition. During error overflow conditions, the new error may not be logged or an error which has already been logged in the status register may be overwritten. For the rules on error overflow, priority, and overwriting, see [MSR0000_0401\[Overflow\]](#).

Overflow alone does not indicate a shutdown condition. Uncorrected errors require software intervention. Therefore, when an uncorrected error cannot be logged, critical error information may have been lost, and `MCi_STATUS[PCC]` may be set. If PCC is indicated, software should terminate system processing to prevent

data corruption (see [2.16.1.6 \[Handling Machine Check Exceptions\]](#)). If PCC is not indicated, any MCA data lost due to overflow was informational only and not critical to system hardware operation.

Table 76: Overwrite Priorities for All Banks

			Older Error			
			Uncorrected		Corrected	
			Enabled	Disabled	Enabled	Disabled
Newer Error	Uncorrected	Enabled	-	-	Overwrite	Overwrite
		Disabled	-	-	Overwrite	Overwrite
	Corrected	Enabled	-	-	-	-
		Disabled	-	-	-	-

2.16.1.4 MCA Initialization

The following initialization sequence must be followed:

- MCI_CTL_MASK registers (see [Table 75 \[MCA register cross-reference table\]](#) for list):
 - BIOS must initialize the mask registers to inhibit error detection prior to the initialization of MCI_CTL and [MSR0000_017B](#).
 - BIOS must not clear MASK bits that are reset to 1.
- The MCI_CTL registers must be initialized by the operating system prior to enabling the error reporting banks in MCG_CTL.

If initializing after a cold reset (see [D18F0x6C\[ColdRstDet\]](#)), then BIOS must clear the MCI_STATUS MSRs. If initializing after a warm reset, then BIOS should check for valid MCA errors and if present save the status for later diagnostic use (see [2.16.1.6 \[Handling Machine Check Exceptions\]](#)).

BIOS may initialize the MCA without setting CR4.MCE; this will result in a system shutdown on any machine check which would have caused a machine check exception (followed by a reboot if configured in the chipset). Alternatively, BIOS that wishes to ensure continued operation in the event that a machine check occurs during boot may write MCG_CTL with all ones and write zeros into each MCI_CTL. With these settings, a machine check error will result in MCI_STATUS being written without generating a machine check exception or a system shutdown. BIOS may then poll MCI_STATUS during critical sections of boot to ensure system integrity. Before passing control to the operating system, BIOS should restore the values of those registers to what the operating system is expecting. (Note that using MCI_CTL to disable error reporting on uncorrected errors may affect error containment; see [2.16.1.3 \[Error Detection, Action, Logging, and Reporting\]](#).)

Before ECC memory has been initialized with valid ECC check bits, BIOS must ensure that no memory operations are initiated if MCA reporting is enabled. This includes memory operations that may be initiated by hardware prefetching or other speculative execution. It is recommended that, until all of memory has been initialized with valid ECC check bits, the BIOS either does not have any valid MTRRs specifying a DRAM memory type or does not enable DRAM ECC machine check exceptions.

2.16.1.5 Error Code

The MCI_STATUS[ErrorCode] field contains information used to identify the logged error. [Table 77 \[Error Code Types\]](#) identifies how to decode ErrorCode. The MCI_STATUS[ErrorCodeExt] field contains detailed, model-specific information that is used to further narrow identification for error diagnosis, but not error handling by software; see [2.16.1.6 \[Handling Machine Check Exceptions\]](#).

For a given error-reporting bank, Error Code Type is used in conjunction with the Extended Error Code (MCi_STATUS[ErrorCodeExt]) to uniquely identify the Error Type; the value of ErrorCodeExt is unique within Error Code Type. Details for each Error Type are described in the tables accompanying the MCi_STATUS register for each bank.

- MC0 (DC); [Table 221 \[MC0 Error Signatures\]](#).
- MC1 (IC); [Table 224 \[MC1 Error Signatures\]](#).
- MC2 (BU); [Table 227 \[MC2 Error Signatures\]](#)
- MC4 (NB); [Table 230 \[MC4 Error Signatures, Part 1\]](#) and [Table 231 \[MC4 Error Signatures, Part 2\]](#).
- MC5 (FR); [Table 239 \[MC5 Error Signatures\]](#).

Table 77: Error Code Types

Error Code	Error Code Type	Description
0000 0000 0001 TTLL	TLB	TT = Transaction Type LL = Cache Level
0000 0001 RRRR TTLL	Memory	Errors in the cache hierarchy (not in NB) RRRR = Memory Transaction Type TT = Transaction Type LL = Cache Level
0000 1PPT RRRR IILL	Bus	General bus errors including link and DRAM PP = Participation Processor T = Timeout RRRR = Memory Transaction Type II = Memory or IO LL = Cache Level
0000 01UU 0000 0000	Internal Unclassified	Internal unclassified errors UU = Internal Error Type

Table 78: Error codes: transaction type (TT)

TT	Transaction Type
00	Instr: Instruction
01	Data
10	Gen: Generic
11	Reserved

Table 79: Error codes: cache level (LL)

LL	Cache Level
00	Reserved
01	L1: Level 1
10	L2: Level 2
11	LG: Generic

Table 80: Error codes: memory transaction type (RRRR)

RRRR	Memory Transaction Type
0000	Gen: Generic. Includes scrub errors.

Table 80: Error codes: memory transaction type (RRRR)

RRRR	Memory Transaction Type
0001	RD: Generic Read
0010	WR: Generic Write
0011	DRD: Data Read
0100	DWR: Data Write
0101	IRD: Instruction Fetch
0110	Prefetch
0111	Evict
1000	Snoop (Probe)

Table 81: Error codes: participation processor (PP)

PP	Participation Processor
00	SRC: Local node originated the request
01	RES: Local node responded to the request
10	OBS: Local node observed the error as a third party
11	Generic

Table 82: Error codes: memory or IO (II)

II	Memory or IO
00	Mem: Memory Access
01	Reserved
10	IO: IO Access
11	Gen: Generic

Table 83: Error codes: Internal Error Type (UU)

UU	Internal Error Type
00	Reserved
01	Reserved
10	HWA: Hardware Assertion
11	Reserved

2.16.1.6 Handling Machine Check Exceptions

A machine check handler is invoked to handle an exception for a particular core. Because MCA registers are generally not shared among cores, the handler does not need to coordinate register usage with handler instances on other cores. Those few MCA registers which are shared are noted in the register description. (See also [2.4.2.1 \[Registers Shared by Cores in a L2 complex\].](#))

For access to the core MC2 registers, [MSRC001_10A0\[McaToMstCoreEn\]](#) allows a single core to access the registers through MSR space without contention from other cores. This organization of registers on a per core basis allows independent execution, simplifies exception handling, and reduces the number of conditions which are globally fatal.

For access to the NB MCA registers, [D18F3x44\[NbMcaToMstCpuEn\]](#) allows a single core (the NBC) to access the registers through MSR space without contention from other cores. This organization of registers on a per core basis allows independent execution, simplifies exception handling, and reduces the number of conditions which are globally fatal.

At a minimum, the machine check handler must be capable of logging error information for later examination. The handler should log as much information as is needed to diagnose the error.

More thorough exception handler implementations can analyze errors to determine if each error is recoverable by software. If a recoverable error is identified, the exception handler can attempt to correct the error and restart the interrupted program. An error may not be recoverable for the process or virtual machine it directly affects, but may be containable, so that other processes or virtual machines in the system are unaffected and system operation is recovered; see [2.16.1.6.1 \[Differentiation Between System-Fatal and Process-Fatal Errors\]](#).

Machine check exception handlers that attempt to recover must be thorough in their analysis and the corrective actions they take. The following guidelines should be used when writing such a handler:

- Data collection:
 - All status registers in all error reporting banks must be examined to identify the cause of the machine check exception.
 - Read [MSR0000_0179\[Count\]](#) to determine the number of status registers visible to the core. The status registers are numbered from 0 to one less than the value found in [MSR0000_0179\[Count\]](#). For example, if the Count field indicates five status registers are supported, they are numbered MC0_STATUS to MC4_STATUS. These are generically referred to as MCi_STATUS.
 - Check the valid bit in each status register (MCi_STATUS[Val]). The remainder of the status register should be examined only when its valid bit is set.
 - When identifying the error condition and determining how to handle the error, portable exception handlers should examine the following MCi_STATUS fields: ErrorCode, UC, PCC, CECC, UECC, Deferred, Poison. The expected settings of these and other fields in MCi_STATUS are identified in the error signatures tables which accompany the descriptions of each MCA status register. See [2.16.1.5 \[Error Code\]](#) for a discussion of error codes and pointers to the error signatures tables.
 - MCi_STATUS[ErrorCodeExt] should generally not be used by portable code to identify the error condition because it is model specific. ErrorCodeExt is useful in determining the error sub-type for root cause analysis.
 - Error handlers should collect all available MCA information (status register, address register, miscellaneous register, etc.), but should only interrogate details to the level which affects their actions. Lower level details may be useful for diagnosis and root cause analysis, but not for error handling.
- Recovery:
 - Check the valid MCi_STATUS registers to see if error recovery is possible.
 - Error recovery is not possible when the processor context corrupt indicator (MCi_STATUS[PCC]) is set to 1.
 - The error overflow status indicator (MCi_STATUS[Overflow]) does not indicate whether error recovery is possible. See [2.16.1.3.2 \[Error Logging During Overflow\]](#).
 - If error recovery is not possible, the handler should log the error information and return to the operating system for system termination.
 - Check MCi_STATUS[UC] to see if the processor corrected the error. If UC is set, the processor did not correct the error, and the exception handler must correct the error prior to attempting to restart the interrupted program. If the handler cannot correct the error, it should log the error information and return to the operating system. If the error affects only process data, it may be possible to terminate only the affected process or virtual machine. If the error affects processor state, continued use of that processor should not occur. See individual error descriptions for further guidance.

- If [MSR0000_017A\[RIPV\]](#) is set, the interrupted program can be restarted reliably at the instruction pointer address pushed onto the exception handler stack if any uncorrected error has been corrected by software. If RIPV is clear, the interrupted program cannot be restarted reliably, although it may be possible to restart it for debugging purposes. As long as PCC is clear, it may be possible to terminate only the affected process or virtual machine.
- When logging errors, particularly those that are not recoverable, check [MSR0000_017A\[EIPV\]](#) to see if the instruction pointer address pushed onto the exception handler stack is related to the machine check. If EIPV is clear, the address is not ensured to be related to the error.
- See [2.16.1.6.1 \[Differentiation Between System-Fatal and Process-Fatal Errors\]](#) for more explanation on the relationship between PCC, RIPV, and EIPV.
- Exit:
 - When an exception handler is able to successfully log an error condition, clear the `MCi_STATUS` registers prior to exiting the machine check handler. Software is responsible for clearing at least `MCi_STATUS[Val]`.
 - Prior to exiting the machine check handler, be sure to clear [MSR0000_017A\[MCIP\]](#). MCIP indicates that a machine check exception is in progress. If this bit is set when another machine check exception occurs in the same core, the processor enters the shutdown state.

Additional machine check handler portability can be added by having the handler use the `CPUID` instruction to identify the processor and its capabilities. Implementation specific software can be added to the machine check exception handler based on the processor information reported by `CPUID`.

In cases where sync flood is the recommended response to a particular error, a machine check exception cannot be used in lieu of the sync flood to stop the propagation of potentially bad data.

2.16.1.6.1 Differentiation Between System-Fatal and Process-Fatal Errors

The bits `MCi_STATUS[PCC]`, [MSR0000_017A\[RIPV\]](#), and [MSR0000_017A\[EIPV\]](#) form a hierarchy, used by software to determine the degree of corruption and recoverability in the system.

[Table 84](#) shows how these bits are interpreted.

Table 84: Error Scope Hierarchy

PCC	UC	RIPV	EIPV	Deferred	Poison	Comments
1	1	-	-	-	-	System fatal error. Signaled via machine check exception, action required. Error has corrupted system state (PCC=1). The error is fatal to the system and the system processing must be terminated.
0	1	1	1	-	-	

Table 84: Error Scope Hierarchy

PCC	UC	RIPV	EIPV	Deferred	Poison	Comments
0	1	0	-	-	0/1	Hardware uncorrected, software containable error. Signaled via machine check exception, action required. The error is confined to the process, however the process cannot be restarted even if the uncorrected error is corrected by software. Poison=1; the error is due to consumption of poison data. If the affected process or virtual machine is terminated, the system may continue operation.
0	0	-	-	1	0	Deferred error. Action optional. A latent error has been discovered, but not yet consumed; a machine check exception will be generated if the affected data is consumed. Error handling software may attempt to correct this data error, or prevent access by processes which map the data, or make the physical resource containing the data inaccessible. Note: May be detected on a demand access or a scrub access.
0	0	-	-	0	0	Corrected error. Signaled via error thresholding mechanisms (2.16.1.7 [Error Thresholding]); no action required.

2.16.1.7 Error Thresholding

For some types of errors, the hardware maintains counts of the number of errors. When the counter reaches a programmable threshold, an event may optionally be triggered to signal software. This is known as error thresholding. The primary purpose of error thresholding is to help software recognize an excessive rate of errors, which may indicate marginal or failing hardware. This information can be used to make decisions about deconfiguring hardware or scheduling service actions. Counts are incremented for corrected, deferred, and uncorrected errors.

The error thresholding hardware counts only the number of errors; it is up to software to track the errors reported over time in order to determine the rate of errors. Thresholding gives error counts on groups of resources. In order to make decisions on individual resources, a finer granularity of error information, such as MCA information for specific errors, must be utilized in order to obtain more accurate counts and to limit the scope of actions to affected hardware.

Thresholding is performed for “Error Threshold Groups” identified in the list below. For all error threshold groups, some number of corrected errors is expected and normal. There are numerous factors influencing error rates, including temperature, voltage, operating speed, and geographic location. In order to accommodate the various factors, including software latency to respond and track the error thresholding, additional guardband above the normal rates is recommended before error rates are considered abnormal for purposes of hardware action.

The {MC0, MC1, MC2, MC5} error thresholding banks maintains counters, but do not provide interrupts when the threshold is reached; these counters must be polled.

Error thresholding groups:

- DRAM (MC4)
 - Memory errors are counted and polled or reported via [MSR0000_0413](#).
 - DRAM errors are the errors listed in [Table 229 \[MC4 Error Descriptions\]](#) as “D” (DRAM) in the ETG (Error Threshold Group) column.
 - Operating systems can avoid or stop using memory pages with excessive errors.
- Links (MC4)
 - Link errors are counted and reported via [MSRC000_0408](#).
 - Link errors are the errors listed in [Table 229 \[MC4 Error Descriptions\]](#) as “L” (Cache) in the ETG (Error Threshold Group) column.
 - For a link exhibiting excessive errors, it may be possible to reduce errors by lowering the link frequency or reducing the link width (if a bad lane can be avoided). See [2.11 \[Root Complex\]](#) for details and restrictions on configuring links.

In rare circumstances, such as two simultaneous errors in the same error thresholding group, it is possible for one error not to increment the counter. In these conditions, `MCi_STATUS[Overflow]` may indicate that an overflow occurred, but the error counter may only indicate one error.

2.16.1.8 Scrub Rate Considerations

This section gives guidelines for the scrub rate settings available in [D18F3x58 \[Scrub Rate Control\]](#) and [MSRC001_10A0 \[L2I Configuration \(L2I_CFG\)\]](#). Scrubbers are used to periodically read cacheline sized data locations and associated tags. There are two primary benefits to scrubbing. First, scrubbing corrects any corrected errors which are discovered before they can migrate into uncorrected errors. This is particularly important for soft errors, which are caused by external sources such as radiation and which are temporary conditions which do not indicate malfunctioning hardware. Second, scrubbers help identify marginal or failed hardware by finding and logging repeated errors at the same locations (see also [2.16.1.7 \[Error Thresholding\]](#)).

There are many factors which influence scrub rates. Among these are:

- The size of memory or cache to be scrubbed
- Resistance to upsets
- Geographic location and altitude
- Alpha particle contribution of packaging
- Performance sensitivity
- Risk aversion

The baseline recommendations in [Table 85](#) are intended to provide excellent protection at most geographic locations, while having no measurable effect on performance. Adjustments may be necessary due to special circumstances. Refer to JEDEC standards for guidelines on adjusting for geographic location.

Table 85: Recommended Scrub Rates per Node

Register	Memory Size per Node (GB)	Register Setting	Scrub Rate
MSRC001_10A0 [L2ScrubberInterval]	-	100h	98.6 ms

Table 85: Recommended Scrub Rates per Node

Register	Memory Size per Node (GB)	Register Setting	Scrub Rate
D18F3x58[DramScrub]	0 GB == Size	00h	Disabled
	0 GB < Size <= 1 GB	12h	5.24 ms
	1 GB < Size <= 2 GB	11h	2.62 ms
	2 GB < Size <= 4 GB	10h	1.31 ms
	4 GB < Size <= 8 GB	0Fh	655.4 us
	8 GB < Size <= 16 GB	0Eh	327.7 us
	16 GB < Size <= 32 GB	0Dh	163.8 us
	32 GB < Size <= 64 GB	0Ch	81.9 us
	64 GB < Size <= 128 GB	0Bh	41.0 us
	128 GB < Size <= 256 GB	0Ah	20.5 us
	256 GB < Size	09h	10.2 us

For steady state operation, finding a range of useful scrub rates may be performed by selecting a scrub rate which is high enough to give good confidence about protection from accumulating errors and low enough that it has no measurable effect on performance. The above baselines are made to maximize error coverage without affecting performance and not based on specific processor soft error rates.

For low power states in which the processor core is halted, the power management configuration may affect scrubbing; see [2.8.3 \[Memory Scrubbers\]](#).

2.16.1.9 Error Diagnosis

This section describes generalized information and algorithms for diagnosing errors. The primary goal of diagnosis is to identify the failing component for repair purposes. The secondary goal is to identify the smallest possible sub-component for deallocation, deconfiguration, or design/manufacturing root cause analysis.

Indictment means identifying the part in error. The simplest form of indictment is *self-indictment*, where the bank reporting the error is the faulty unit. The next simplest form of indictment is *eyewitness indictment*, where the faulty unit is not the bank reporting the error, but is identified unambiguously. Both of these forms can be considered direct indictment; the information for indictment is contained in the MCA error information. If an error is not directly indicted, then identifying the faulty unit is more difficult and may not be an explicit part of the error log.

In general, an address logged in the MCA is useful for direct indictment only if the address identifies a physical location in error, such as a cache index. Logical addresses, while identifying the data, do not identify the location of the data.

If possible, physical storage locations in caches should be checked to determine whether the error is a soft error (a temporary upset of the stored value) or a hard fault (malfunctioning hardware). A location which has had a soft error can be corrected by writing a new value to the location; a reread of the location should see the new value. Hard faults cannot be corrected by writing a new value; the hardware persistently returns the previous value. If such checking is not possible, a grossly simplifying assumption can be made that uncorrected errors are hard and corrected errors are soft. Repeated corrected errors from the same location are an indication that the fault is actually hard.

Determining whether corrected errors represent a hard fault or a soft error requires understanding the access

patterns and any attempts to correct the faulty data in place. An attempt to correct the data in place creates two *epochs*, one before the correction event, and one after. If an error is seen at the same location in two different epochs (especially back-to-back epochs), it is more likely that the cause is a hard fault, since the error has persisted or repeated through an in place correction. The more epochs in which a error is seen, the higher the likelihood of it being caused by a hard fault.

As an example, consider a corrected error found during a read from DRAM. If the DRAM redirect scrubber is enabled (**D18F3x5C**[ScrubReDirEn]), the data in error is corrected in place, and this event conceptually creates a new epoch. If the original fault was due to a soft error, a read of the same data in the new epoch should not encounter a data error. If the original fault was due to a hard fault (e.g., a stuck bit), a read of the data in the new epoch will likely result in another corrected or uncorrected error.

There are numerous correction events that can be used to separate time periods into epochs. These include DRAM redirect scrubs, DRAM sequential scrubs, cache scrubs, cache writes, cache flushes, resets, and others.

2.16.1.9.1 Common Diagnosis Information

A common set of diagnosis information is useful for many problems. [Table 86](#) indicates the minimum set of generally useful diagnostic information that should be collected by software, unless the specifics of the problem are known to be narrower, based on the error code or other information.

It is useful to collect configuration information to ensure that the behavior is not caused by misconfiguration.

Table 86: Registers Commonly Used for Diagnosis

MCA Bank	Status	Configuration
MC0	MSR0000_0401 MSR0000_0402 MSR0000_0403	MSR0000_0400 MSRC001_1022 MSRC001_0044
MC1	MSR0000_0405 MSR0000_0406 MSR0000_0407	MSR0000_0404
MC2	MSR0000_0409 MSR0000_040A MSR0000_040B	MSR0000_0408 MSRC001_0046 MSRC001_1023
MC3	Reserved	Reserved
MC4	MSR0000_0411 MSR0000_0412 MSR0000_0413 MSRC000_0408 D18F3x54 D18F2xAC	MSR0000_0410 MSRC001_0048 D18F3x40 D18F3x44 D18F3xE4 D18F3xE8 MSRC001_001F D18F3x180
MC5	MSR0000_0415 MSR0000_0416 MSR0000_0417	MSR0000_0414

If examining MCA registers after startup, determine the cause of the startup:

- INIT; [D18F0x6C](#)[InitDet].
- Cold reset; [D18F0x6C](#)[ColdRstDet].
- Warm reset; if not INIT or cold reset.

To see if a link failure occurred, examine [D18F0x\[E4,C4,A4,84\]](#)[LinkFail]. If set, look for additional information:

- Receipt of a sync, such as during a sync flood, saves a status of Sync Error in MC4_STATUS.
- CRC error saves a status of CRC Error in MC4_STATUS. See [D18F0x\[E4,C4,A4,84\]](#)[CrcErr,Crc-FloodEn].
- Link not present does not save status in MC4_STATUS. See [D18F0x\[E4,C4,A4,84\]](#)[InitComplete].

Other registers may be needed depending on the specific error symptoms.

2.16.2 DRAM ECC Considerations

DRAM is protected by an error correcting code (ECC). The DRAM error correcting code features an ECC word formed by a symbol based code. The x4 code uses thirty-six 4-bit symbols to make a 144-bit ECC word made up of 128 data bits and 16 check bits.

The x4 code is a single symbol correcting (SSC) and a double symbol detecting (DSD) code. This means the x4 code is able to correct 100% of single symbol errors (any bit error combination within one symbol), and detect 100% of double symbol errors (any bit error combination within two symbols).

Systems supporting ECC and non-ECC memory regions should use the non-ECC memory for the Frame Buffer only.

2.16.2.1 ECC Syndromes

For memory errors, the sections below describe how to find the DIMM in error. The process varies slightly according to the ECC code in use. To determine which ECC code is being used, see [D18F3x180](#)[EccSymbolSize].

For correctable errors, the DIMM in error is uniquely identified by the error address ([MSR0000_0412](#)[ErrAddr]) and the ECC syndrome ([MSR0000_0411](#)[Syndrome[15:8]] and [MSR0000_0411](#)[Syndrome[7:0]]). The error address maps to the two DIMMs composing the 128-bit line, and the ECC syndrome identifies one DIMM by identifying the symbol within the line.

2.16.2.1.1 x4 ECC

The use of x4 ECC is indicated in [D18F3x180](#)[EccSymbolSize].

The syndrome field uniquely identifies the failing bit positions of a correctable ECC error. Only syndromes identified by [Table 87](#) are correctable by the error correcting code.

Symbols 00h-0Fh map to data bits 0-63; symbols 10h-1Fh map to data bits 64-127; symbols 20-21h map to ECC check bits for data bits 0-63; symbols 22-23h map to ECC check bits for data bits 64-127.

To use [Table 87](#), first find the 16-bit syndrome value in the table. This is performed by using low order 4 bits of the syndrome to select the appropriate error bitmask column. The entire four digit syndrome should then be in

one of the rows of that column. The Symbol In Error row indicates which symbol, and therefore which DIMM has the error, and the column indicates which bits within the symbol.

For example, if the ECC syndrome is 6913h, then symbol 05h has the error, and bits 0 and 1 within that symbol are corrupted, since the syndrome is in column 3h (0011b). Symbol 05h maps to bits 23-20, so the corrupted bits are 20 and 21.

Table 87: x4 ECC Correctable Syndromes

Symbol In Error	Error Bitmask														
	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
Data 0	e821	7c32	9413	bb44	5365	c776	2f57	dd88	35a9	a1ba	499b	66cc	8eed	1afe	f2df
Data 1	5d31	a612	fb23	9584	c8b5	3396	6ea7	eac8	b7f9	4cda	11eb	7f4c	227d	d95e	846f
Data 2	0001	0002	0003	0004	0005	0006	0007	0008	0009	000a	000b	000c	000d	000e	000f
Data 3	2021	3032	1013	4044	6065	7076	5057	8088	a0a9	b0ba	909b	c0cc	e0ed	f0fe	d0df
Data 4	5041	a082	f0c3	9054	c015	30d6	6097	e0a8	b0e9	402a	106b	70fc	20bd	d07e	803f
Data 5	be21	d732	6913	2144	9f65	f676	4857	3288	8ca9	e5ba	5b9b	13cc	aded	c4fe	7adf
Data 6	4951	8ea2	c7f3	5394	1ac5	dd36	9467	a1e8	e8b9	2f4a	661b	f27c	bb2d	7cde	358f
Data 7	74e1	9872	ec93	d6b4	a255	4ec6	3a27	6bd8	1f39	f3aa	874b	bd6c	c98d	251e	51ff
Data 8	15c1	2a42	3f83	cef4	db35	e4b6	f177	4758	5299	6d1a	78db	89ac	9c6d	a3ee	b62f
Data 9	3d01	1602	2b03	8504	b805	9306	ae07	ca08	f709	dc0a	e10b	4f0c	720d	590e	640f
Data 10	9801	ec02	7403	6b04	f305	8706	1f07	bd08	2509	510a	c90b	d60c	4e0d	3a0e	a20f
Data 11	d131	6212	b323	3884	e9b5	5a96	8ba7	1cc8	cdf9	7eda	afeb	244c	f57d	465e	976f
Data 12	e1d1	7262	93b3	b834	59e5	ca56	2b87	dc18	3dc9	ae7a	4fab	642c	85fd	164e	f79f
Data 13	6051	b0a2	d0f3	1094	70c5	a036	c067	20e8	40b9	904a	f01b	307c	502d	80de	e08f
Data 14	a4c1	f842	5c83	e6f4	4235	1eb6	ba77	7b58	df99	831a	27db	9dac	396d	65ee	c12f
Data 15	11c1	2242	3383	c8f4	d935	eab6	fb77	4c58	5d99	6e1a	7fdb	84ac	956d	a6ee	b72f
Data 16	45d1	8a62	cfb3	5e34	1be5	d456	9187	a718	e2c9	2d7a	68ab	f92c	befd	734e	369f
Data 17	63e1	b172	d293	14b4	7755	a5c6	c627	28d8	4b39	99aa	fa4b	3c6c	5f8d	8d1e	eeff
Data 18	b741	d982	6ec3	2254	9515	fbd6	4c97	33a8	84e9	ea2a	5d6b	11fc	a6bd	c87e	7f3f
Data 19	dd41	6682	bbc3	3554	e815	53d6	8e97	1aa8	c7e9	7c2a	a16b	2ffc	f2bd	497e	943f
Data 20	2bd1	3d62	16b3	4f34	64e5	7256	5987	8518	aec9	b87a	93ab	ca2c	e1fd	f74e	dc9f
Data 21	83c1	c142	4283	a4f4	2735	65b6	e677	f858	7b99	391a	badb	5cac	df6d	9dee	1e2f
Data 22	8fd1	c562	4ab3	a934	26e5	6c56	e387	fe18	71c9	3b7a	b4ab	572c	d8fd	924e	1d9f
Data 23	4791	89e2	ce73	5264	15f5	db86	9c17	a3b8	e429	2a5a	6dcb	f1dc	b64d	783e	3faf
Data 24	5781	a9c2	fe43	92a4	c525	3b66	6ce7	e3f8	b479	4a3a	1dbb	715c	26dd	d89e	8f1f
Data 25	bf41	d582	6ac3	2954	9615	fed6	4397	3ea8	81e9	eb2a	546b	17fc	a8bd	c27e	7d3f
Data 26	9391	e1e2	7273	6464	f7f5	8586	1617	b8b8	2b29	595a	cacb	dcdc	4f4d	3d3e	aeaf
Data 27	cce1	4472	8893	fdb4	3155	b9c6	7527	56d8	9a39	12aa	de4b	ab6c	678d	ef1e	23ff
Data 28	a761	f9b2	5ed3	e214	4575	1ba6	bcc7	7328	d449	8a9a	2dfb	913c	365d	688e	cfef
Data 29	ff61	55b2	aad3	7914	8675	2ca6	d3c7	9e28	6149	cb9a	34fb	e73c	185d	b28e	4def

Table 87: x4 ECC Correctable Syndromes

Symbol In Error	Error Bitmask														
	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
Data 30	5451	a8a2	fcf3	9694	c2c5	3e36	6a67	ebe8	bfb9	434a	171b	7d7c	292d	d5de	818f
Data 31	6fc1	b542	da83	19f4	7635	acb6	c377	2e58	4199	9b1a	f4db	37ac	586d	82ee	ed2f
Check0	be01	d702	6903	2104	9f05	f606	4807	3208	8c09	e50a	5b0b	130c	ad0d	c40e	7a0f
Check1	4101	8202	c303	5804	1905	da06	9b07	ac08	ed09	2e0a	6f0b	f40c	b50d	760e	370f
Check2	c441	4882	8cc3	f654	3215	bed6	7a97	5ba8	9fe9	132a	d76b	adfc	69bd	e57e	213f
Check3	7621	9b32	ed13	da44	ac65	4176	3757	6f88	19a9	f4ba	829b	b5cc	c3ed	2efe	58df

2.16.3 Error Injection and Simulation

Error injection allows the introduction of errors into the system for test and debug purposes. See the following sections for error injection details:

- DRAM: See [2.16.3.1 \[DRAM Error Injection\]](#).
- Link:
 - [D18F3x44](#)[GenLinkSel, GenSubLinkSel, GenCrcErrByte1, GenCrcErrByte0].

Error simulation involves creating the appearance to software that an error occurred, and can be used to debug machine check interrupt handlers. This is performed by manually setting the MCA registers with desired values, and then driving the software via INT18. See [MSRC001_0015](#)[McStatusWrEn] for making MCA registers writable for non-zero values. When McStatusWrEn is set, privileged software can write non-zero values to the specified registers without generating exceptions, and then simulate a machine check using the INT18 instruction (INTn instruction with an operand of 18). Setting a reserved bit in these registers does not generate an exception when this mode is enabled. However, setting a reserved bit may result in undefined behavior.

2.16.3.1 DRAM Error Injection

This section gives details and examples on injecting errors into DRAM using [D18F3xBC_x8](#) [DRAM ECC]. The intent of DRAM error injection is to cause a discrepancy between the stored data and the stored ECC value. Therefore, DRAM error injection is only possible on DRAM which supports ECC, and in which [D18F2x90_dct\[0\]](#)[DimmEccEn] and [D18F3x44](#)[DramEccEn] are set.

The memory subsystem operates on 64-byte cachelines. The following fields are used to set how the cacheline is to be corrupted in DRAM:

- [D18F3xB8](#)[ArrayAddress] selects a cacheline quadrant (16-byte section) of the cacheline. Each cacheline quadrant is protected by an ECC word. Note that there are special requirements for which bits are used to specify the target quadrant.
- [D18F3xBC_x8](#)[ErrInjEn] selects a 16-bit word of the cacheline quadrant selected in ArrayAddress. The 16-bit word identified as ECC[15:0] refers to the bits which store the ECC value; the other 16-bit words address the data on which the ECC is calculated. One or more of these 16-bit words can be selected, and the error bitmask indicated in EccVector is applied to each of the selected words.
- [D18F3xBC_x8](#)[EccVector] is a bitmask which selects the individual bits to be corrupted in the 16-bit words selected by ErrInjEn. When selecting the bits to be corrupted for correctable or uncorrectable errors, consider the ECC scheme being used, including symbol size; see [2.16.2 \[DRAM ECC Considerations\]](#) for more details. Note that corrupting more than two symbols may exceed the limits of the ECC to detect the errors; for testing purposes it is recommended that no more than two symbols be corrupted in a single cacheline quadrant.

The distinction between [D18F3xBC_x8\[DramErrEn\]](#) and [D18F3xBC_x8\[EccWrReq\]](#) is that [DramErrEn](#) is used to continuously inject errors on every write. This bit is set and cleared by software. [EccWrReq](#) is used to inject an error on only one write. This bit is set by software and is cleared by hardware after the error is injected.

When performing DRAM error injection on multi-node systems, [D18F3xB8](#) and [D18F3xBC_x8](#) of the NB to which the memory is attached must be programmed.

The following can be used to trigger the injection:

- The memory address is not an explicit parameter of the error injection interface. Once the error injection registers [D18F3xB8](#) and [D18F3xBC](#) are set, the next non-cached access of the appropriate type will trigger the mechanism and apply it to the accessed address. The access should be non-cached so that it is ensured to be seen by the memory controller. Possible methods to ensure a non-cached access include using the appropriate MTRR to set the memory type to UC or turning off caches. If it is important to know the address, then system activity must be quiesced so that the access can take place under careful software control. Once the error injection pattern is set in [D18F3xB8](#) and [D18F3xBC_x8](#):
 - Set either [D18F3xBC_x8\[EccWrReq\]](#) or [D18F3xBC_x8\[DramErrEn\]](#) to enable the triggering mechanism.
 - The next non-cached access of the appropriate type will trigger the mechanism and apply it to the accessed address.

After the error is injected, the data must be accessed in order for the error detection to be triggered. The error address logged in [MSR0000_0412](#) will correspond to the cacheline quadrant that contains the error.

When using [MSR0000_0411](#) to read [MC4_STATUS](#) after an error injection and subsequent error detection, be aware that the setting of [D18F3x44\[NbMcaToMstCpuEn\]](#) can cause different cores to see different values. Alternatively, [MC4_STATUS](#) can be read through the PCI-defined configuration space aliases [D18F3x4C](#) and [D18F3x48](#), which do not return different values to different cores, regardless of the setting of [D18F3x44\[NbMcaToMstCpuEn\]](#).

Example 1: Injecting a correctable error:

- Program error pattern:
 - [D18F3xB8\[ArraySelect\]](#)=1000b // select DRAM as target
 - [D18F3xB8\[ArrayAddress\]](#)=000000000b // select 16-byte (128-bit) section
 - [D18F3xBC_x8\[ErrInjEn\]](#)=000000001b // select 16-bit word in 16-byte section
 - [D18F3xBC_x8\[EccRdReq\]](#)=0 // not a read request
 - [D18F3xBC_x8\[EccVector\]](#)=0001h // set bitmask to inject error into only one symbol
- Program error trigger:
 - [D18F3xBC_x8\[DramErrEn\]](#)=0 // inject only a single error
 - [D18F3xBC_x8\[EccWrReq\]](#)=1 // a write request; enable injection on next write
- Clean up // if programmed for continuous errors
 - [D18F3xBC_x8\[DramErrEn\]](#)=0 // inject only a single error

2.17 Fusion Controller Hub

The processor contains an integrated Fusion Controller Hub (FCH). The FCH supports the following interfaces:

- Universal Serial Bus (USB) versions 2.0, and 3.0
- Serial ATA revision 3.0
- Secure Digital (SD)
- System Management Bus (SMBus)
- Low Pin Count (LPC) bus and SPI interface
- High Definition (HD) audio
- Serial IRQ
- Serial Peripheral Interface (SPI) ROM
- Advanced Configuration and Power Interface (ACPI)

The FCH also comprises the following functions:

- Real-Time Clock (RTC)
- Programmable Interrupt Controller (PIC)
- System clock generation
- System Management Interrupt (SMI)
- General-Purpose I/O (GPIO)
- Power management
- Watchdog Timer (WDT)

2.17.1 MMIO Programming for Legacy Devices

The legacy devices LPC, IOAPIC, ACPI and Watchdog Timer require the base address of the Memory Mapped IO registers to be assigned before these logic blocks are accessed. The Memory Mapped IO register base address and its entire range should be mapped to non-posted memory region by programming the CPU register. See BIOS Developer's Guide for details.

2.17.2 USB Controllers

This processor supports three USB 2.0 EHCI controllers and one USB 3.0 xHCI controller. USB 2.0 HUBs are added between the USB2.0 PHYs and the EHCI controllers, so that both USB2.0 and USB1.1 devices can be supported. Each EHCI controller has 2 internal ports. Port 0 connects to the HUB and port 1 is used as the debug port. The first two HUBs each has 4 USB ports and the third HUB has 2 ports.

Refer to the following for the USB controller register definitions:

- [Section 3.26.4.1 \[USB 2.0 \(EHCI\)\]](#) for the EHCI controllers
- [Section 3.26.4.2 \[USB 3.0 \(xHCI\)\]](#) for the xHCI controller

2.17.2.1 USB Power Management

USB power management functions are controlled by registers outside the USB controller registers spaces. See the following register definitions in [3.26.13 \[Power Management \(PM\) Registers\]](#):

- [PMx80\[UsbPeriodicalSetBmSts, Usb20SetBmSts\]](#)
- [PMxED \[USB Gating\]](#)
- [PMxEF \[USB Enable\]](#)
- [PMxF0 \[USB Control\]](#)

2.17.2.2 USB Interrupts

The interrupt mapping is specified by [IOC00 \[Pci_Intr_Index\]](#) and [IOC01 \[Pci_Intr_Data\]](#). By default, USB interrupts are routed to PCI INTA#, B#, and C#.

For normal operations, MSI must be disabled in all OHCI and EHCI controllers.

2.17.2.3 BIOS Programming Requirements For USB Reset During S3 Resume

Set [PMxF0\[UsbKbResetEnable\]](#)=1 to enable the USB controller to get reset by any software that generates a PCIRST# condition (e.g. a keyboard reset or a write to [IOCF9](#)). To avoid losing the USB connection status during the S3 resume procedure, BIOS must ensure that [PMxF0\[UsbKbResetEnable\]](#)=0 before any software-generated PCIRST# reset condition during S3 resume.

2.17.2.4 Enabling the xHCI Controller

Software performs the following sequence to enable the xHCI controller:

1. Program [PMxEF\[Usb3EhciEnable\]](#)=0.
2. Program [PMxEF\[PortRoutingSelect\]](#)=1.
3. Program [XHCI_PMx00\[Xhci0Enable\]](#)=1.

2.17.2.5 USB2.0 Controller PHY Configuration and Calibration

Software performs the following sequence to configure EHCI common PHY for each USB port to be used shortly after chip boot up and after USB2.0 EHCI controller initiated the calibration. The register settings have to be re-established to ensure USB2.0 PHY is properly calibrated. It is not needed after waking up from S3.

1. Program [HSSLEW](#)=10b.
 - A. Program [EHCI\[3:1\]xB4\[PortNumber\]](#) with the controller port number according to [Table 88](#).
 - B. Program [EHCI\[3:1\]xB4\[VControlModeSel\]](#)=0110b.
 - C. Program [HSSLEW](#) value at [EHCI\[3:1\]xB4\[1:0\]](#)=10b.
 - D. Program [EHCI\[3:1\]xB4\[VLoadB\]](#)=1.
 - E. Wait for [EHCI\[3:1\]xB4\[VBusy\]](#)=0.
 - F. Program [EHCI\[3:1\]xB4\[VLoadB\]](#)=0.
 - G. Wait for [EHCI\[3:1\]xB4\[VBusy\]](#)=0.
 - H. Program [EHCI\[3:1\]xB4\[VLoadB\]](#)=1 to lock the PHY control interface.
2. Program [EHCI\[3:1\]xD0\[BgAdj\]](#)=7.
3. Program [EHCI\[3:1\]xC4\[IRefAdj\]](#)=2.
4. Program [EHCI\[3:1\]xC4\[XRefAdj\]](#)=2.
5. Program [EHCI\[3:1\]xC4\[PVI\]](#)=1.
6. Program [EHCI\[3:1\]xC4\[CPAdj\]](#)=1.
7. Program [EHCI\[3:1\]xC4\[DLLControl\]](#)=90h.
8. Program [EHCI\[3:1\]xD4\[PllFilter\]](#)=1.
9. Program [EHCI\[3:1\]xD4\[CalEnable\]](#)=0.
10. Wait for 200 ns.
11. Program [EHCI\[3:1\]xD4\[CalEnable\]](#)=1.
12. Wait for 400 ns.
13. Program [EHCI\[3:1\]xD4\[CalEnable\]](#)=0.

2.17.2.6 USB2.0 Controller Common PHY Impedance Calibration

The following sequence enables USB2.0 common PHY impedance calibration.

IF ([D18F3x1FC\[USB2CompCal\[3:0\]\]](#)==0h) THEN

- A. Program [EHCI\[3:1\]xC0\[NewCalBus\[7:0\]\]](#)=0.

- B. Program `EHCI[3:1]x0[AddToCommonCalibration]=0` and `EHCI[3:1]x0[UseCommonCalibration]=1` for auto-calibration.

ELSE

- A. Program `EHCI[3:1]x0[NewCalBus[6:3]]=D18F3x1FC[USB2CompCal[3:0]]` to set the new calibration bus value.
- B. Program `EHCI[3:1]x0[AddToCommonCalibration]=0` and `EHCI[3:1]x0[UseCommonCalibration]=0` to have NewCaluBus replace ComCalBus for calibration.

ENDIF

2.17.2.7 USB2.0 Controller ISO Device CRC False Error Detection

Software performs the following sequence to program CDR phase shift limit for each USB port to be used:

1. Program `EHCI[3:1]xB4[PortNumber]` with the controller port number according to [Table 88](#).
2. Program `EHCI[3:1]xB4[VControlModeSel]=0111b`.
3. Program `EHCI[3:1]xB4[2:0]=101b`.
4. Program `EHCI[3:1]xB4[VLoadB]=1`.
5. Wait for `EHCI[3:1]xB4[VBusy]=0`.
6. Program `EHCI[3:1]xB4[VLoadB]=0`.
7. Wait for `EHCI[3:1]xB4[VBusy]=0`.
8. Program `EHCI[3:1]xB4[VLoadB]=1` to lock the PHY control interface.

Table 88: USB Port to `EHCI[3:1]xB4[PortNumber]` Mapping

USB Port	Software selects by programming
0	<code>EHCI1xB4[PortNumber]=0h</code>
1	<code>EHCI1xB4[PortNumber]=1h</code>
2	<code>EHCI1xB4[PortNumber]=2h</code>
3	<code>EHCI1xB4[PortNumber]=3h</code>
4	<code>EHCI2xB4[PortNumber]=0h</code>
5	<code>EHCI2xB4[PortNumber]=1h</code>
6	<code>EHCI2xB4[PortNumber]=2h</code>
7	<code>EHCI2xB4[PortNumber]=3h</code>
8	<code>EHCI3xB4[PortNumber]=0h</code>
9	<code>EHCI3xB4[PortNumber]=1h</code>

2.17.2.8 xHC USB2.0 Common PHY Calibration

The following programming sequence has to be carried out shortly after chip boot up and after USB2.0 EHCI/XHCI controller initiated the calibration. The register settings have to be re-established to ensure USB2.0 PHY is properly calibrated. It is not needed after waking up from S3.

1. Program `HSSLEW=10b`.
 - A. Program `D10F0x4C_x4000_0000[PortNumber]` with the controller port number according to [Table 89](#).
 - B. Program `D10F0x4C_x4000_0000[VControlModeSel]=0110b`.
 - C. Program `HSSLEW` value at `D10F0x4C_x4000_0000[1:0]=10b`.
 - D. Program `D10F0x4C_x4000_0000[VLoadB]=1`.
 - E. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.
 - F. Program `D10F0x4C_x4000_0000[VLoadB]=0`.
 - G. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.

- H. Program `D10F0x4C_x4000_0000[VLoadB]=1` to lock the PHY control interface.
2. Program `D10F0x4C_x4000_0050[BgAdj]=7`.
3. Program `D10F0x4C_x4000_000C[IRefAdj]=2`.
4. Program `D10F0x4C_x4000_000C[XRefAdj]=2`.
5. Program `D10F0x4C_x4000_000C[PVI]=1`.
6. Program `D10F0x4C_x4000_000C[CPAdj]=1`.
7. Program `D10F0x4C_x4000_000C[DllControl]=90h`.
8. Program `D10F0x4C_x4000_0054[PllFilter]=1`.
9. Program `D10F0x4C_x4000_0054[CalEnable]=0`.
10. Wait for 200 ns.
11. Program `D10F0x4C_x4000_0054[CalEnable]=1`.
12. Wait for 400 ns.
13. Program `D10F0x4C_x4000_0054[CalEnable]=0`.

2.17.2.9 xHC USB2.0 Port Drive Strength Adjustment

The drive strength is auto-calibrated on power up. If the calibrated value needs to be adjusted, use the following procedure to do the adjustment.

1. Program `D10F0x4C_x4000_0000[PortNumber]` with the controller port number according to [Table 89](#).
2. Program `D10F0x4C_x4000_0000[VControlModeSel]=1000b` to select Group 8.
3. Program `D10F0x4C_x4000_0000[VControl[4]]=0b` and `D10F0x4C_x4000_0000[VControl[5]]=1b` to use (Actual+Adjusted) CalAmp value for drive strength.
4. Program `D10F0x4C_x4000_0000[VControl[3:0]]` with desired drive strength adjustment.
 - a. `D10F0x4C_x4000_0000[VControl[3]]` is the sign bit. 1= Negative offset. 0= Positive offset.
5. Program `D10F0x4C_x4000_0000[VLoadB]=1`.
6. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.
7. Program `D10F0x4C_x4000_0000[VLoadB]=0`.
8. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.
9. Program `D10F0x4C_x4000_0000[VLoadB]=1` to lock the PHY control interface.

2.17.2.10 USB3.0 PHY Auto-Calibration Enablement

BIOS enables USB3.0 PHY auto-calibration as follows:

1. Program `XHCI_PMx8C[PllVcoTune[3:0]]=0011b`.
2. Program `XHCI_PMx8C[CrPlCalibEn]=1`.

2.17.2.11 xHCI ISO Device CRC False Error Detection

Software performs the following sequence to program CDR phase shift limit for each USB port to be used:

1. Program `D10F0x4C_x4000_0000[PortNumber]` with the controller port number according to [Table 89](#).
2. Program `D10F0x4C_x4000_0000[VControlModeSel]=0111b`.
3. Program `D10F0x4C_x4000_0000[2:0]=101b`.
4. Program `D10F0x4C_x4000_0000[VLoadB]=1`.
5. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.
6. Program `D10F0x4C_x4000_0000[VLoadB]=0`.
7. Wait for `D10F0x4C_x4000_0000[VBusy]=0`.
8. Program `D10F0x4C_x4000_0000[VLoadB]=1` to lock the PHY control interface.

Table 89: USB Port to `D10F0x4C_x4000_0000[PortNumber]` Mapping

USB Port	Software selects by programming
----------	---------------------------------

Table 89: USB Port to D10F0x4C_x4000_0000[PortNumber] Mapping

8	D10F0x4C_x4000_0000[PortNumber]=0h
9	D10F0x4C_x4000_0000[PortNumber]=1h

2.17.2.12 xHCI PHY Clock Gating

The following programming sequence configures the clock gating in the xHCI PHY. They must be performed for each port after enabling xHCI controller and need to be restored after all power state resumes.

1. Program D10F0x4C_x4000_0000[VLoadB]=1.
2. Program D10F0x4C_x4000_0000[PortNumber] with the controller port number according to Table 89.
3. Program D10F0x4C_x4000_0000[VControlModeSel]=0011b.
4. Program D10F0x4C_x4000_0000[2]=1.
5. Read D10F0x4C_x4000_0000[VBusy] to ensure it is 0.
6. Program D10F0x4C_x4000_0000[VLoadB]=0.
7. Wait for D10F0x4C_x4000_0000[VBusy]=0.
8. Program D10F0x4C_x4000_0000[VLoadB]=1 to lock the PHY control interface.

2.17.2.13 xHCI Firmware Preload

Software performs the following programming sequence for firmware preload. Firmware preload should be executed before BIOS de-asserts XHCI_PMx00[U3CoreReset].

1. Enable firmware preload by programming XHCI_PMx00[FwLoadMode]=1.
2. Program XHCI_PMx04[XhciFwPreloadType] with 1 for boot RAM preload and 0 for instruction RAM preload.
3. Program XHCI_PMx04[XhciFwRomAddr] with the offset of the application firmware in the external ROM.
4. Program XHCI_PMx08[XhciFwRamAddr]= 0.
5. Program XHCI_PMx08[XhciFwSize]=8000h.
6. Program XHCI_PMx00[FwPreloadStart]=1 to start firmware preload.
7. Wait for XHCI_PMx00[FwPreloadComplete]=1.
8. Program XHCI_PMx00[FwPreloadStart]=0.
9. Program XHCI_PMx00[U3CoreReset]=0 to de-assert xHC reset.

2.17.2.14 xHCI Clear Pending PME on Sx State Entry

During S3/S4 entry with wake from Sx state enabled, if the xHCI controller received a wake event before the system shutdown into Sx state is completed, D10F0x54[PmeStatus] may remain set when the system enters into Sx state. This will prevent subsequent wake events from being propagated to the ACPI controller. BIOS should write 1 to clear D10F0x54[PmeStatus] if D10F0x54[PmeStatus] is 1 and ACPI GEvent status bit is clear on entry into S3/S4 state.

2.17.3 SATA

2.17.3.1 SATA Operating Mode

The SATA host controller can operate in the following modes:

- IDE mode.
- AHCI mode.

Software programs the subclass code and programming interface register to enable the SATA controller as IDE controller or AHCI controller.

1. Program [D11F0x40\[SubclassCodeWriteEnable\]](#)=1.
2. Program [D11F0x08\[SubclassCode\]](#) and [D11F0x08\[ProgramIF\[7:0\]\]](#) according to [Table 255 \[SATA Controller Subclass Code and ProgramIF Settings\]](#).
3. Program [D11F0x40\[SubclassCodeWriteEnable\]](#)=0.

2.17.3.2 SATA Drive Detection in IDE mode

The following sequence should be included in the SBIOS drive identification loop for SATA drive detection in IDE mode.

1. If any of the SATA port status register at [SATAx1\[A,2\]8\[DET\]](#)==03h, program [IDE\[1:0\]x06\[DriveHead\]](#)=A0h for the corresponding port and go to Step 2.
Else, no SATA drives are attached; exit the detection loop program.
2. If ([IDE\[1:0\]x06\[DriveHead\]](#)==A0h) && ([IDE\[1:0\]x07\[7\]](#)==0) && ([IDE\[1:0\]x07\[3\]](#)==0) for a port, the SATA device on that port is ready. [IDE\[1:0\]x07\[7\]](#) means BSY status, [IDE\[1:0\]x07\[3\]](#) means DRQ status.
Else, loop until 30 s time-out; There is no SATA device attached if a time-out occurs.
Note: Most drives don't need 30 s time-out. The 30 s time-out is only needed for some particularly large capacity SATA drives, which require a longer spin-up time during a cold boot.

2.17.3.3 SATA PHY Auto-Calibration Enablement

BIOS enables SATA PHY auto-calibration as follows:

1. Program [D11F0x88\[PIIVcoTune\]](#)=0011b.
2. Program [PMxDC\[PlIcalibEn\]](#)=1.
3. Reset PHY:
 - A. Program [D11F0x84\[RSTB\]](#)=0 to assert reset.
 - B. Wait for 100 us.
 - C. Program [D11F0x84\[RSTB\]](#)=1 to release PHY reset.
4. Issue AHCI reset to reset the host controller.
 - A. Program [SATAx04\[HR\]](#)=1. Hardware will clear this bit after AHCI reset is completed.

2.17.3.4 SATA PHY Fine Tuning

The SBIOS should program the SATA controller in the sequence indicated below to fine tune the PHY. Performing this procedure provides sufficient time for the SATA controllers to correctly complete SATA drive detection. The same procedure is required after the system resumes from the S3 state.

- Gen 3 settings:
 - Program [D11F0x80\[15:0\]](#)=0130h to select Gen 3 for all ports.
 - Program [D11F0x98\[31:0\]](#)=0040f407h.
- Gen 2 settings:
 - Program [D11F0x80\[15:0\]](#)=0120h to select Gen 2 for all ports.
 - Program [D11F0x98\[31:0\]](#)=00403204h to fine tune PHY for Gen 2.
- Gen 1 settings:
 - Program [D11F0x80\[15:0\]](#)=0110h to select Gen 1 for all ports.
 - Program [D11F0x98\[31:0\]](#)=00403103h to fine tune PHY for Gen 1.
- Squelch detector settings:

2.17.3.5 SATA PHY Reference Clock Selection

SATA PHY reference clock can originate from either internal or external clock. The following steps select SATA PHY reference clock source:

1. Select one of the following options for reference clock.
 - Internal 48 MHz differential non-spread clock from pad (default):
 - a. Program [PMxDA\[RefClkSel\]](#)=1 to select reference clock from internal RDL.
 - b. Program [PMxDA\[RefDivSel\]](#)=0 to set PHY divider to div-by-1.
 - c. Program [D11F0x8C\[PLL_CLKF\]](#)=7Dh to set PLL feedback clock divider value to 6 GHz/48 MHz=7Dh.
 - External 25 MHz crystal non-spread clock from external clock chip (the clock path has to be routed on the board, in order for the setting to take effect):
 - a. Program [PMxDA\[RefClkSel\]](#)=0 to select reference clock from an external source, via the PAD_XTALI and PAD_XTALO, to SATA PHY.
 - b. Program [PMxDA\[RefDivSel\]](#)=0 to set PHY divider to div-by-1.
 - c. Program [D11F0x8C\[PLL_CLKF\]](#)=F0h to set PLL feedback clock divider value to 6 GHz/25 MHz=F0h.
 - Internal 100 MHz spread clock:
 - a. Program [D11F0x84\[PE\]](#)=0 to disable PHY.
 - b. Program [PMxDA\[RefClkSel\]](#)=1 to select reference clock from internal RDL.
 - c. Program [PMxDA\[RefDivSel\]](#)=2 to set PHY divider to div-by-1.
 - d. Program [D11F0x8C\[PLL_CLKF\]](#)=F0h to set PLL feedback clock divider value to 6 GHz/25 MHz=F0h.
 - e. Program [D11F0x84\[PE\]](#)=1 to enable PHY.
2. Reset PHY:
 - A. Program [D11F0x84\[RSTB\]](#)=0 to assert reset.
 - B. Wait for 100 us.
 - C. Program [D11F0x84\[RSTB\]](#)=1 to release PHY reset.
3. Issue AHCI reset to reset the host controller.
 - A. Program [SATAx04\[HR\]](#)=1. Hardware will clear this bit after AHCI reset is completed.

2.17.3.6 SATA Power Management

2.17.3.6.1 SATA PHY Power Saving

The SATA PHY has different power saving states with the Active state consuming the most power. The table below summarizes the different controls during each power saving state.

Table 90: SATA PHY Power Saving States

Power Saving States	PMxDA[SetMaxGen2]	PMxDA[SataEnable]	SATAx1[9,1]8[ICC]	D11F0x40[SataPortDisable]
Active	0	1	1	0
Active with SetMaxGen2	1	1	1	0
Partial	x	1	2	0
Slumber	x	1	6	0
Lane Disabled	x	1	x	1
PHY Power Down	x	0	x	1

2.17.3.7 Enable Shadow Register Reload

When default PHY settings are not optimal, they need to be adjusted by software. Once these settings are re-programmed, software shall program [D11F0x84\[S5ShadowLdDis\]](#) to 0 to turn on shadow register reloading. When default PHY settings are optimal and need no adjustment, [D11F0x84\[S5ShadowLdDis\]](#) needs not to be

altered and shadow register preloading is effectively disabled.

2.17.3.8 SATA Interrupt Handling

2.17.3.8.1 Line Interrupt

The SATA interrupt mapping is specified by [IOC00 \[Pci_Intr_Index\]](#) and [IOC01 \[Pci_Intr_Data\]](#).

2.17.3.8.2 MSI Message

SATA controller supports message-based interrupts. When MSI is enabled and the SATA controller owns N ports, as specified by [SATAx0C \[Ports Implemented \(PI\)\]](#), [D11F0x50\[MMC\]](#) should be programmed according to platform configurations:

- If [SATAx00\[CCCS\]](#)==1, [D11F0x50\[MMC\]](#) should be the minimum of 2M which satisfies $2M \geq (N+1)$. For example: if BIOS knows that system has 2 SATA ports in AHCI mode ($N=2$). If [SATAx00\[CCCS\]](#)==1, BIOS should program [D11F0x50\[MMC\]](#)=2 to request 4 MSI interrupts.

MSI capability pointer should be hidden when SATA subclass is configured in IDE mode (see [2.17.3.1 \[SATA Operating Mode\]](#)).

2.17.3.9 Clear status of SATA PERR

BIOS should clear SATA PERR status soon after a cold boot, warm boot, any S3/S1 resume events, or an [IOCF9](#) initiated reset outside a warm boot before any SATA activity is initiated.

- Write 1 to clear [SMIx3C\[SataPerr\]](#).
- Write 1 to clear [SMIx84\[RasEvent55\]](#).

2.17.4 LPC Bus Interface

BIOS should program [D14F3xA0\[SpiBaseAddr\]](#) with non-zero address to enable the MMIO access to SPI ROM control registers.

2.17.4.1 Enabling LPC DMA function

If DMA is required for the LPC interface, program the registers as the following:

- Program [D14F3x40\[LegacyDmaEnable\]](#)=1.
- Program [D14F3x78\[NoHog\]](#)=1.
- Program [PMx08\[ArbDmaDis\]](#)=1.
- Program [D14F3x78\[LDRQ1\]](#)=1 and [D14F3x78\[LDRQ0\]](#)=1.
- Program [PMx04\[LegacyDmaPrefetchEnhance\]](#)=1 for non-DOS mode. Note: This bit should only be enabled in the ACPI method (called by the OS). This ensures that it is enabled only when the system is in Windows® mode. Under DOS mode, this feature may not work properly and may cause the floppy to malfunction.

2.17.4.2 Enabling SPI 100

To enable the support for SPI 100 MHz speed, software needs to program [SPIx20\[UseSpi100\]](#)=1. SPI 100 should be enabled on after the Auto ROM sizing has been completed (Auto ROM sizing is done by the software only during the initial boot when the system power state transitions from G3->S5->S0). The actual read speed also depends on the settings at [SPIx22 \[SPI100 Speed Config\]](#).

2.17.5 SD Controller

The SD controller is SD 3.0 compliant host controller.

2.17.6 HD Audio

The FCH has one High Definition Audio controller (HD audio), which can be enabled/disabled by programming [PMxEB\[AzEnable\]](#).

The HD audio controller supports up to 4 codecs with one AZ_SDIN pin from each codec. The four AZ_SDIN pins are multiplexed with GPIO167-170 (GPIOxA7-GPIOxAA). If a particular pin is to be used for HD audio functionality and the integrated pull-down is to be used rather than external pull-down resistor, in addition to being configured for HD audio, the following bits need to be set:

- GPIOxA7=3Eh
- GPIOxA8=3Eh
- GPIOxA9=3Eh
- GPIOxAA=3Eh

For example, if only GPIO167 and GPIO168 are to be used for HD audio, then only GPIOxA7 and GPIOxA8 need to be programmed to 3Eh. See [3.26.12 \[GPIO Pin control registers\]](#).

2.17.6.1 HD Audio AF and MSI Capability

The Advanced Feature (AF) capability and MSI capability in HD audio controller are controlled by [D14F2x44\[EnAFCap\]](#) and [D14F2x44\[EnMsiCap\]](#) respectively. The settings of these two bits affect how the AF capability and MSI capability are linked to the capability pointer linked list.

Table 91: HD Audio AF and MSI Capability Settings

D14F2x44 [EnAF-Cap]	D14F2x44 [EnMsi-Cap]	D14F2x50 [NextPtr]	D14F2x60 [CapID]	D14F2x60 [NextPtr]	D14F2x70 [AFC-apID]	D14F2x70 [NextPtr]	D14F2x70 [AFLengt h]	D14F2x70 [25:24]
0	0	0h	0h	0h	0h	0h	0h	0h
0	1	60h	5h	0h	0h	0h	0h	0h
1	0	70h	0h	0h	13h	0h	6h	3h
1	1	60h	5h	70h	13h	0h	6h	3h

2.17.7 ASF Controller

The ASF controller can be used in a slave mode to support DASH clients. When the platform is configured for DASH the BIOS should at the minimum set the following registers to ensure the ASF is configured in slave mode and the control commands are defined properly in the ASF tables.

- When operating in Master mode, BIOS should program [PMx00\[AsfSmMasterEn\]](#)=1. BIOS should program [PMx00\[AsfSmMasterEn\]](#) back to 0 after the master operations are done.
- When operating in Slave mode, BIOS should program [PMx00\[AsfSmMasterEn\]](#)=0.

In addition to support remote DASH operations, BIOS should ensure that the ASF tables define the correct command codes and [ASFx0E \[RemoteCtrlAdr\]](#) has to be programmed with the same value reported in the ASF control data table.

ASF controller can behave like remote control device to accept the command from client side to do the reset/power down/power up/power cycle. BIOS reports those in ASF control data table. The command and command data are defined in [Table 92](#).

Table 92: ASF Remote Control Commands

Remote Control	Control Command	Control data
Reset	50h	00h
Power Up	51h	00h
Power Down	52h	00h
Power Cycle	53h	00h

2.17.8 Integrated Micro-Controller

The FCH supports an integrated micro-controller (IMC)..

The IMC can be enabled by programming [PMxD6](#)[ImcEnable].

2.17.9 On-Chip Clock Generator

There are two clocking modes in which this chip can be brought up based on the boot strap pin LPCCLK1. SBIOS should read [MISCx80](#)[ClkGenStrap] to determine clock generator mode. SBIOS should program [MISCx40](#)[OscClkSwitchEn] to 1 to select average 14 MHz OSC clock provided by internal PLL in both internal and external clocking mode.

2.17.9.1 Power Saving In Internal Clock Mode

GPP_CLK_P/N pins are powered off when this chip is strapped to use an external clock, and powered on when strapped to operate in internal clock mode. The GPP_CLK clocks are mapped to corresponding CLK_REQ# pins. The GPP_CLK0/1/2/3 mapping is defined at [MISCx00](#)[15:0]. SLT_GFX_CLK mapping is defined at [MISCx04](#)[7:4]. In internal clock mode, a selected GPP_CLK can be powered off when the corresponding CLK_REQ# is asserted. See [MISCx00](#) && [MISCx04](#) for details.

Software can also program [MISCx04](#)[PCIE_RCLK_PowerDownEnable]=1 to turn off 100 MHz reference clock input buffer in internal clock generator mode for power saving.

2.17.9.2 Global A-Link / B-Link Clock Gating

Software needs to program [MISCx2C](#)[ALinkClkGateOffEn]=1 and [PMx04](#)[ABLinkClkGateEn]=1 to enable global A-link clock gate off function.

Software needs to program [MISCx2C](#)[BlinkClkGateOffEn]=1 and [PMx04](#)[ABLinkClkGateEn]=1 to enable global B-link clock gate off function.

[PMx04](#)[ABLinkClkGateEn] is a non-sticky bit and needs to be programmed to 1 after PCI reset and S3/S4/S5 state, if global A-link / B-link gating function has been enabled. [MISCx2C](#)[ALinkClkGateOffEn] and [MISCx2C](#)[BlinkClkGateOffEn] are sticky bits.

2.17.9.3 CG_PLL CMOS Clock Driver Setting for Power Saving

Software programs the following registers to select CMOS clock driver for CG1_PLL in internal & external clock mode for power saving:

- Program [MISCx1C](#)[CgpllClkDriverUpdate]=0.
- Program [MISCx1C](#)[Cg1ClkDriverType]=1011b and Program [MISCx1C](#)[Cg1RefClk48MHzDriverType]=0010b.
- Perform a software reset through [IOCF9](#).

These settings will only need to be applied once when the chip is booting up from G3-S5->S0. These is no

need to do this for every reset since the setting is sticky.

2.17.10 FCH Gasket

The FCH gasket (SBG) is responsible for converting between the protocols used by the interface and the A-link bridge interface. BIOS should program [PMxE0](#) to set up base address before accessing AB configuration registers.

2.17.11 A-Link Bridge

The A-link bridge (AB) sits behind the FCH gasket.

2.17.11.1 Detection of Upstream Interrupts

BIOS should enable AB to detect upstream interrupts for the purpose of system management.

- Program [ABx04_x94](#)[MsiAddr[39:20]] with CPU interrupt delivery address [39:20].
- Program [ABx04_x94](#)[MsiAddrEn]=1.

2.17.11.2 AB Memory Power Saving

The following sequence enables AB memory power saving:

- Program [MISCx68](#)[ABBypassMemDsd]=0 to enable AB memory DSD.
- Program [ABx04_x58](#)[BlMemSDEn]=1 to enable B-link memory shutdown.
- Program [ABx04_x58](#)[AlMemSDEn]=1 to enable A-link memory shutdown.

2.17.11.3 AB Internal Clock Gating

The following sequence enables AB internal clock gating:

- Program [ABx04_x54](#)[BlClkGateDelay]=10h to set the number of cycles to delay before gating B-link clocks.
- Program [ABx04_x10054](#)[AlClkGateDelay]=10h to set the number of cycles to delay before gating A-link clocks.
- Program [ABx04_x54](#)[BlClkGateEn]=1 to enable medium grain B-link clock gating.
- Program [ABx04_x54](#)[DbgClkGateEn]=1 to disable debug only B-link clocks.
- Program [ABx04_x10054](#)[AlClkGateEn]=1 to enable medium grain A-link clock gating.
- Program [ABx04_x10054](#)[DbgClkGateEn]=1 to disable debug only A-link clocks.

2.17.11.4 AB 32/64 Byte DMA Write Enable

To enable AB 32 byte/64 byte DMA write, software needs to program [ABx04_x54](#)[UpWr16BMode]=0 and [ABx04_x54](#)[UpSWrByteCntSbgMode]=1 to disable 16 byte write splitting and enable SBG mode byte-count calculation logic. Software should also make sure [ABx04_x204](#)[Dma16ByteMode]=0.

3 Registers

This section provides detailed field definitions for the core register sets in the processor.

3.1 Register Descriptions and Mnemonics

Each register in this document is referenced with a mnemonic. Each mnemonic is a concatenation of the register-space indicator and the offset of the register. Here are the mnemonics for the various register spaces:

- **IOXXX**: x86-defined input and output address space registers; XXX specifies the hexadecimal byte address of the IO instruction. This space includes IO-space configuration access registers, [IOCF8 \[IO-Space Configuration Address\]](#) and [IOCFC \[IO-Space Configuration Data Port\]](#), and the legacy block configuration registers. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.2 \[IO Space Registers\]](#) and [3.26.1 \[Legacy Block Configuration Registers \(IO\)\]](#).
- **APICXX0**: APIC memory-mapped registers; XX0 is the hexadecimal byte address offset from the base address. See [2.4.8.1.2 \[APIC Register Space\]](#).
- **CPUID FnXXXX_XXXX_EiX[_xYYY]**: processor capabilities information returned by the CPUID instruction. See [3.18 \[CPUID Instruction Registers\]](#). Each core may only access this information for itself.
- **MSRXXXX_XXXX**: **MSRs**; XXXX_XXXX is the hexadecimal MSR number. This space is accessed through x86-defined RDMSR and WRMSR instructions. Unless otherwise specified there is one set of these registers **Per-core**. See [2.4.1 \[L2 complex\]](#).
- **DXFYxZZZ**: PCI-defined configuration space; X specifies the hexadecimal device number (this may be 1 or 2 digits), Y specifies the function number, and ZZZ specifies the hexadecimal byte address (this may be 2 or 3 digits); e.g., D18F3x40 specifies the register at device 18h, function 3, and address 40h. See [2.7 \[Configuration Space\]](#), for details about configuration space.
 - Some register in D18F2xXXX have the _dct[0] mnemonic suffix. See [2.9.3 \[DCT Configuration Registers\]](#).
- **IOMMUxX_XXXX**: IOMMU memory mapped registers; X_XXXX specifies the hexadecimal byte address offset (this may be 2 to 5 digits) from the base address register; The base address for this space is specified by [D0F2x44 \[IOMMU Base Address Low\]](#) and [D0F2x48 \[IOMMU Base Address High\]](#). See [3.15 \[IOMMU Memory Mapped Registers\]](#).
- **PMCxxx**: core performance monitor events; XXX is the hexadecimal event counter number programmed into [MSRC001_00\[03:00\]\[EventSelect\]](#); See [2.6.1.1 \[Core Performance Monitor Counters\]](#).
 - When PMCxxx is followed by [z:y] then UnitMask[z:y] is being specified.
- **L2IPMCxxx**: L2 performance monitor events; XXX is the hexadecimal event counter number programmed into [MSRC001_023\[6,4,2,0\]\[EventSelect\]](#); See [2.6.1.2 \[L2I Performance Monitor Counters\]](#).
 - When PMCxxx is followed by [z:y] then UnitMask[z:y] is being specified.
- **NBPMCxxx**: NB performance monitor events; XXX is the hexadecimal event counter number programmed into [MSRC001_024\[6,4,2,0\]\[EventSelect\]](#); See [2.6.1.3 \[NB Performance Monitor Counters\]](#).
 - When NBPMCxxx is followed by [z:y] then UnitMask[z:y] is being specified.
- **ABxXX**: ALink Bridge registers; XX specifies the hexadecimal byte address offset from the base address. The base address for this space is specified by [PMxE0 \[ABRegBar\]](#). Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.2 \[AB Configuration Registers\]](#).
- **IDE[Y]xXX**: SATA controller IDE mode IO mapped registers; XX specifies the hexadecimal byte address offset from the base address; Y specifies primary drive (0) or secondary drive (1). The base address for this space is specified in [Table 256 \[IDE Compatibility Mode and Native Mode Address Mapping\]](#). Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.3.2.1 \[IDE Compatibility Mode and Native Mode Registers\]](#).
- **IDE_BMxXX**: SATA controller IDE mode IO mapped bus master registers; XX specifies the hexadecimal byte address offset from the base address. The base address for this space is specified by [D11F0x20 \[Bus](#)

Master Interface Register Base Address (BAR4)]. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.3.2.2 \[IDE Bus Master Registers\]](#).

- **SATAxXXX**: SATA controller AHCI mode memory mapped registers; XXX specifies the hexadecimal byte address offset from the base address. The base address for this space is specified by [D11F0x24 \[AHCI Base Address \(BAR5\)\]](#). Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.3.3 \[SATA Memory Mapped AHCI Registers\]](#).
- **SATA_EMxXX**: SATA controller AHCI mode memory mapped enclosure buffer management registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.3.3.3 \[Enclosure Buffer Management Registers\]](#).
- **EHCI[Y]xXX**: USB EHCI controller memory mapped registers; XX specifies the hexadecimal byte address offset from the base address; Y specifies the EHCI controller number; e.g., EHCI[1]x04 specifies EHCI controller 1 memory mapped control register offset 04. The base address for this space is specified by [D\[16,13,12\]F0x10 \[BAR_EHCI\]](#). Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.4.1.2 \[EHCI Memory Mapped IO Registers\]](#).
- **xHCI_PMxXX**: USB xHCI controller ACPI memory mapped registers; XX specifies the hexadecimal byte address offset from the base address. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.4.2.2 \[xHCI Power Management Registers\]](#).
- **SDHCxXX**: Secure Digital host controller memory mapped registers; XX specifies the hexadecimal byte address offset from the base address. The base address for this space is specified by {[D14F7x14 \[Upper Base Address Reg 0\]](#), [D14F7x10 \[Base Address Reg 0\]](#)}. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.6.2 \[SD Host Controller Configuration Registers \(SDHC\)\]](#).
- **ASFxXX**: ASF registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.7.2 \[ASF \(Alert Standard Format\) Registers\]](#).
- **SMBUSxXX**: SMBus registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.7.3 \[SMBus Registers\]](#).
- **IOAPICxXX**: IOAPIC registers; XX specifies the hexadecimal byte address offset from the base address. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.8 \[IOAPIC Registers\]](#).
- **SPIxXX**: SPI memory mapped registers; XX specifies the hexadecimal byte address offset from the base address. The base address is specified by [D14F3xA0 \[SPI Base_Addr\]](#). Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.9.2 \[SPI Registers\]](#).
- **HPETxXXX**: HPET registers; XXX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.10 \[High Precision Event Timer \(HPET\) Registers\]](#).
- **MISCxXX**: ACPI miscellaneous control registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.11 \[Miscellaneous \(MISC\) Registers\]](#).
- **GPIOxXX**: GPIO registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.12.1 \[GPIO Registers\]](#).
- **IOMUXxXX**: IOMUX registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.12.2 \[IOMUX Registers\]](#).

- **PMxXX**: power management registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.13 \[Power Management \(PM\) Registers\]](#).
- **PM2xXX**: power management block 2 registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.14 \[Power Management Block 2 \(PM2\) Registers\]](#).
- **SMIxXX**: SMI registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.16 \[SMI Registers\]](#).
- **WDTxXX**: Watchdog timer registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.17 \[Watchdog Timer \(WDT\) Registers\]](#).
- **AcDcTimerxXX**: AC/DC wake alarm timer registers; XX specifies the hexadecimal byte address offset. Unless otherwise specified, there is one set of these registers per node; the registers in a node are accessible to any core on that node. See [3.26.18 \[Wake Alarm Device \(AcDcTimer\) Registers\]](#).

Each mnemonic may specify the location of one or more registers that share the same base definition. A mnemonic that specifies more than one register will contain one or more ranges within braces. The ranges are specified as follows:

- Comma separated lists [A,B]: Define specific instances of a register, e.g., D0F3x[1,0]40 defines two registers D0F3x40 and D0F3x140.
- Colon separated ranges [A:B]: Defines all registers that contain the range between A and B. Examples:
 - D0F3x[50:40] defines five registers D0F3x40, D0F3x44, D0F3x48, D0F3x4C, and D0F3x50.
 - D[8:2]F0x40 defines seven registers D2F0x40, D3F0x40, D4F0x40, D5F0x40, D6F0x40, D7F0x40, and D8F0x40.
 - D0F0xE4_x013[2:0]_0000 defines three registers D0F0xE4_x0130_0000, D0F0xE4_x0131_0000, and D0F0xE4_x0132_0000.
- Colon separated ranges with an explicit step [A:BstepC]: Defines the registers from A to B, C defines the offset between registers., e.g., D0F3x[50:40:step8] defines three registers D0F3x40, D0F3x48, and D0F3x50.

The processor includes a single set of IO-space and configuration-space registers. However, APIC, CPUID, and MSR register spaces are implemented once per processor core. Access to IO-space and configuration space registers may require software-level techniques to ensure that no more than one core attempts to access a register at a time.

The following is terminology found in the register descriptions.

Table 93: Terminology in Register Descriptions

Term	Definition
BIOS	Software recommendation syntax. See 3.1.2 [Software Recommendation (BIOS, SBIOS)] .
SBIOS	
See	Reference to remote definition.
Alias	<p>The alias keyword allows the definition of a soft link between two registers.</p> <ul style="list-style-type: none"> • X is an alias of Y: X is a soft link to the register Y. • X1, X2 are an alias of Y: Both X1 and X2 are soft links to Y.

Table 93: Terminology in Register Descriptions

Term	Definition
IF	Allows conditional definition as a function of register fields. The syntax is: <ul style="list-style-type: none">• IF (conditional-expression) THEN definition ENDIF.• IF (conditional-expression) THEN definition ELSE definition ENDIF.• IF (conditional-expression) THEN definition ELSEIF (conditional-expression) THEN definition ELSE definition ENDIF.
THEN	
ELSEIF	
ELSE	
ENDIF	
Access Types	
Read	Capable of being read by software.
Read-only	Capable of being read but not written by software.
Write	Capable of being written by software.
Write-only	Write-only. Capable of being written by software. Reads are undefined.
Read-write	Capable of being written by software and read by software.
Set-by-hardware	Register field is set high by hardware, set low by hardware, or updated by hardware.
Cleared-by-hardware	
Updated-by-hardware	
Updated-by-SMU	
Write-1-to-clear	Software must write a 1 to the bit in order to clear it. Writing a 0 to these bits has no affect.
Write-1-only	Software can set the bit high by writing a 1 to it. Writes of 0 have no effect.
Reset-applied	Takes effect on warm reset.
GP-read	GP exception occurs on read.
GP-write	GP exception occurs on write.
GP-read-write	GP exception occurs on a read or a write.
Per-core	One instance per core. Only valid for MMIO config space. Writes of these bits from one core only affect that core’s register. Reads return the values appropriate to that core.
Per-compute-unit	One instance per compute unit. Writes of these bits from one core only affect that compute unit’s register. Reads return the values appropriate to that compute unit. See 2.4.2.1 [Registers Shared by Cores in a L2 complex].
Per-L2	One instance per L2 cache. See CPUID Fn8000_001D_EAX_x2[NumSharingCache].
Per-node	One instance per node. See 3.1.1 [Northbridge MSRs In Multi-Core Products].
Not-same-for-all	Provide indication as to whether all instances of a given register should be the same across all cores/nodes according to the following equation: SameOnAllCheckEnabled = (Writable && (same-for-all MSR) && ~(not-same-for-all UpdatedByHw)). UpdatedByHw = (Updated-by-hardware set-by-hardware cleared-by-hardware set-when-done cleared-when-done).
Same-for-all	
Field Definitions	
Reserved	Field is reserved for future use. Software is required to preserve the state read from these bits when writing to the register. Software may not depend on the state of reserved fields nor on the ability of such fields to return the state previously written.

Table 93: Terminology in Register Descriptions

Term	Definition
Unused	Field is reserved for future use. Software is not required to preserve the state read from these bits when writing to the register. Software may not depend on the state of unused fields nor on the ability of such fields to return the state previously written.
MBZ	Must be zero. If software attempts to set an MBZ bit to 1, a general-protection exception (#GP) occurs.
RAZ	Read as zero. Writes are ignored, unless RAZ is combined with write-only or write-1-only.
Reset Definitions	
Reset	The reset value of each register is provided below the mnemonic or in the field description. Unless otherwise noted, the register state matches the reset value when RESET_L is asserted (either a cold or a warm reset). Reset values may include: <ul style="list-style-type: none"> • X: an X in the reset value indicates that the field resets (warm or cold) to an unspecified state.
Cold reset	The field state is not affected by a warm reset (even if the field is labeled “cold reset: X”); it is placed into the reset state when PWROK is deasserted. See "Reset" above for the definition of characters that may be found in the cold reset value.
Value	The current value of a read-only field or register. A value statement explicitly defines the field or register as read-only and the value returned under all conditions including after reset events. A field labeled “Value:” will not have a separate reset definition.

3.1.1 Northbridge MSRs In Multi-Core Products

MSRs that control Northbridge functions are shared between all cores on the node in a multi-core processor (e.g. [MSRC001_001F](#)). If control of Northbridge functions is shared between software on all cores, software must ensure that only one core at a time is allowed to access the shared MSR. Some MSR's are conditionally shared; see [D18F3x44](#)[NbMcaToMstCpuEn].

3.1.2 Software Recommendation (BIOS, SBIOS)

The following keywords specify the recommended value to be set by software.

- BIOS: AMD BIOS.
- SBIOS: Platform BIOS.

Syntax: BIOS: integer-expression. Any of the supported tags can be substituted for BIOS.

If “BIOS:” occurs in a register field then the recommended value is applied to the field. If “BIOS:” occurs after a register name but outside of a register field table row then the recommended value is applied to the width of the register.

3.1.3 See Keyword (See:)

There is a special meaning applied to the use of “See:” that differs from the use of See not followed by a “:”.

- See, not followed by a “:”, simply refers the reader to a document location that contains related information.
- See followed by a “:” is a shorthand notation that indicates that the definition for this register or register field inherits all properties and definitions from the register or register field that follows "See:". Any def-

inition local to the register or register field supercedes this inheritance.

“See:” can be used in the following ways:

- Full register width. [CPUID Fn0000_0001_EAX](#) inherits it’s full register width definition from [D18F3xFC](#).
- Register field. [MSR0000_0277\[PA1MemType\]](#) inherits it’s definition from PA0MemType, however, the local reset of 4h overrides the inherited PA0MemType reset of 6h.
- Valid values definition. [MSR0000_020\[E,C,A,8,6,4,2,0\]\[MemType\]](#), for example, inherits the valid values definition from [Table 216 \[Valid Values for Memory Type Definition\]](#).

3.1.4 Mapping Tables

The following mapping table types are defined.

3.1.4.1 Register Mapping

The register mapping table specifies the specific function for each register in a range of registers.

[Table 188](#), for example, specifies that the D18F5x160 function is for NB P-state 0.

3.1.4.2 Index Mapping

The index mapping table is similar to the register mapping table, but specifies the register by index instead of by full register mnemonic.

[Table 147 \[Index Mapping for D18F2x9C_x0D0F_0\[F,8:0\]02_dct\[0\]\]](#), for example, specifies that the [D18F2x98_dct\[0\]\[31:0\]==0D0F_0002h](#), or [D18F2x9C_x0D0F_0002_dct\[0\]](#), function is for Byte 0.

3.1.4.3 Field Mapping

The field mapping table maps the fields of a range of registers. The rows are the registers that are mapped. Each column specifies a field bit range that is mapped by that column for all registers. The cell at the intersection of the register and the field bit range specifies the suffix that is appended to the register field. “Reserved” specifies that the field is reserved for the register of that row.

3.1.4.4 Broadcast Mapping

The broadcast mapping table maps a register address to a range of register addresses that are written as a group when the broadcast register address is written. The register address is formed by the concatenation of the row address with the column address. The cell at the intersection of the row and column address is a range of register addresses that will be written as a group when the row and column address is written.

3.1.4.5 Reset Mapping

The reset mapping table specifies the reset, cold reset, or value for each register in a range of registers.

[Table 211 \[Reset Mapping for CPUID Fn8000_0000_E\[D,C,B\]X\]](#), for example, specifies that the [CPUID Fn0000_0000_EBX](#) register has a value of 6874_7541h, with a comment of “The ASCII characters “h t u A””.

3.1.4.6 Valid Values

The valid values table defines the valid values for one or more register fields. The valid values table is equiva-

lent in function to the Bits/Description tables in register fields (E.g. [MSR0000_0277](#)[PA0MemType]) and is most often used when the table becomes too large and unwieldy to be included into the register field. (E.g. [Table 216](#) [Valid Values for Memory Type Definition])

3.1.4.7 BIOS Recommendations

The BIOS recommendations table defines “BIOS:” recommendations that are conditional and complex enough to warrant a table.

[Table 176](#) [BIOS Recommendations for [D18F2x1B\[4:0\]](#)], for example, specifies the BIOS recommendations for [D18F2x1B0](#)[DcqBwThrotWm] and [D18F2x1B4](#)[DcqBwThrotWm1, DcqBwThrotWm2]. All cells under the “Condition” header for a given row are ANDed to form the condition for the values to the right of the condition. For example, rows 1-3 and column 1 provide the following equivalent BIOS recommendation:

- [D18F2x1B0](#)[DcqBwThrotWm]: BIOS: IF ([DdrRate](#)==667) THEN 4h ELSEIF ([DdrRate](#)==800) THEN 5h ELSEIF ([DdrRate](#)==1066) THEN 6h ELSEIF etc.

3.2 IO Space Registers

See [3.1](#) [Register Descriptions and Mnemonics] for a description of the register naming convention.

IOCF8 IO-Space Configuration Address

Reset: 0. [IOCF8](#) [IO-Space Configuration Address], and [IOCFC](#) [IO-Space Configuration Data Port], are used to access system configuration space, as defined by the PCI specification. [IOCF8](#) provides the address register and [IOCFC](#) provides the data port. Software sets up the configuration address by writing to [IOCF8](#). Then, when an access is made to [IOCFC](#), the processor generates the corresponding configuration access to the address specified in [IOCF8](#). See [2.7](#) [Configuration Space].

[IOCF8](#) may only be accessed through aligned, DW IO reads and writes; otherwise, the accesses are passed to the appropriate IO link. Accesses to [IOCF8](#) and [IOCFC](#) received from an IO link are treated as all other IO transactions received from an IO link and are forwarded based on the settings in [D18F1x\[DC:C0\]](#) [IO-Space Base/Limit]. [IOCF8](#) and [IOCFC](#) in the processor are not accessible from an IO link.

Bits	Description
31	ConfigEn: configuration space enable. Read-write. 1=IO read and write accesses to IOCFC are translated into configuration cycles at the configuration address specified by this register. 0=IO read and write accesses are passed to the appropriate IO link and no configuration access is generated.
30:28	Reserved.
27:24	ExtRegNo: extended register number. Read-write. ExtRegNo provides bits[11:8] and RegNo provides bits[7:2] of the byte address of the configuration register. ExtRegNo is reserved unless it is enabled by MSRC001_001F [EnableCf8ExtCfg].
23:16	BusNo: bus number. Read-write. Specifies the bus number of the configuration cycle.
15:11	Device: bus number. Read-write. Specifies the device number of the configuration cycle.
10:8	Function. Read-write. Specifies the function number of the configuration cycle.
7:2	RegNo: register address. Read-write. See IOCF8 [ExtRegNo].
1:0	Reserved.

IOCFC IO-Space Configuration Data Port

Bits	Description
31:0	Data. Read-write. Reset: 0. See IOCF8 .

3.3 Device 0 Function 0 (Root Complex) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D0F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1566h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D0F0x04 Status/Command

Reset: 0000_0004h.

Bits	Description
31:21	Reserved.
20	CapList: capability list. Read-only. 1=Capability list supported.
19:3	Reserved.
2	BusMasterEn: bus master enable. Read-only.
1	MemAccessEn: memory access enable. Read-only.
0	IoAccessEn: IO access enable. Read-only.

D0F0x08 Class Code/Revision ID

Reset: 0600_0000h.

Bits	Description
31:8	ClassCode: class code. Read-only. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only.

D0F0x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:24	Reserved.
23	DeviceType. Read-only. 0b=Single function device. 1b=Multi-function device.
22:16	HeaderType. Read-only.
15:8	LatencyTimer. Read-only.
7:0	CacheLineSize. Read-only.

D0F0x2C Subsystem and Subvendor ID

Bits	Description
31:16	SubsystemID . Read-only. Value: 1410h.
15:0	SubsystemVendorID . Read-only. Value: 1022h.

D0F0x34 Capabilities Pointer

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer . Read-only. There is no capability list.

D0F0x48 NB Header Write Register

Reset: 0000_0080h.

Bits	Description
31:8	Reserved.
7	DeviceType: device type . Read-write. This field sets the value in the corresponding field in D0F0x0C[DeviceType] . 0b=Single function device. 1b=Multi-function device.
6:0	Reserved.

D0F0x4C PCI Control

Reset: 0000_0000h.

Bits	Description
31:27	Reserved.
26	HPDis: hot plug message disable . Read-write. 1=Hot plug message generation is disabled.
25:24	Reserved.
23	MMIOEnable: memory mapped IO enable . Read-write. 1=Decoding of MMIO cycles is enabled. The MMIO Base/Limit pair (D0F0x64_x17 and D0F0x64_x18) are decoded. This range is used to create an MMIO hole in the DRAM address range used for DMA decoding. DMA writes that fall into the MMIO range are treated as potential p2p requests. DMA reads that fall into the MMIO range are aborted as unsupported requests.
22:15	Reserved.
14:6	Reserved.
5	SerrDis: system error message disable . Read-write. 1=The generation of SERR messages is disabled.
4	PMEDis: PME disable . Read-write. 1=The generation of PME messages is disabled.
3:0	Reserved.

D0F0x60 Miscellaneous Index

Reset: 0000_0000h. The index/data pair registers, [D0F0x60](#) and [D0F0x64](#), are used to access the registers at [D0F0x64_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0x60](#), and then the data is read from or written to the data register, [D0F0x64](#).

Bits	Description
31:8	Reserved.
7:0	MiscIndAddr: miscellaneous index register address. Read-write.

D0F0x64 Miscellaneous Index Data

See [D0F0x60](#). Address: [D0F0x60](#)[MiscIndAddr].

Bits	Description
31:0	MiscIndData: miscellaneous index data register.

D0F0x64_x00 Northbridge Control

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7	HwInitWrLock. Read-write. 1=Lock HWInit registers. 0=Unlock HWInit registers.
6:0	Reserved.

D0F0x64_x0C IOC Bridge Control

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D0F0x64_x0D IOC PCI Configuration

Bits	Description
31	IommuDis. Read-only. Value: Product specific.
30:1	Reserved.
0	PciDev0Fn2RegEn. Read-write. Reset: 1. 1=Enable configuration accesses to device 0 function 2.

D0F0x64_x16 IOC Advanced Error Reporting Control

Reset: 0000_0001h.

Bits	Description
31:1	Reserved.
0	AerUrMsgEn: AER unsupported request message enable. Read-write. BIOS: 0. 1=AER unsupported request messages are enabled.

D0F0x64_x17 Memory Mapped IO Base Address

Reset: 0000_0000h.

Bits	Description
31:0	MmioBase[47:16]: memory mapped IO base address. Read-write.

D0F0x64_x18 Memory Mapped IO Limit

Reset: 0000_0000h.

Bits	Description
31:0	MmioLimit[47:16]: memory mapped IO limit. Read-write.

D0F0x64_x19 Top of Memory 2 Low

Reset: 0000_0000h.

Bits	Description
31:23	Tom2[31:23]: top of memory 2. Read-write. BIOS: MSRC001_001D [TOM2[31:23]]. This field specifies the maximum system address for upstream read and write transactions that are forwarded to the host bridge. All addresses less than this system address are forwarded to DRAM and are not checked to determine if the transaction is a peer-to-peer transaction. All upstream reads with addresses greater than or equal to this system address are master aborted.
22:1	Reserved.
0	TomEn: top of memory enable. Read-write. BIOS: MSRC001_0010 [MtrrTom2En]. 1=Top of memory check enabled.

D0F0x64_x1A Top of Memory 2 High

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	Tom2[39:32]: top of memory 2. Read-write. BIOS: MSRC001_001D [TOM2[39:32]]. See D0F0x64_x19 [Tom2].

D0F0x64_x1D Internal Graphics PCI Control

Reset: 0000_0000h.

Bits	Description
31:4	Reserved.
3	Vga16En: VGA IO 16 bit decoding enable. Read-write. BIOS: D0F0x64_x1D[VgaEn] . 1=Address bits 15:10 for VGA IO cycles are decoded. 0=Address bits 15:10 for VGA IO cycles are ignored.
2	Reserved.
1	VgaEn: VGA enable. Read-write. 1=Enable VGA range in Intgfx.
0	Reserved.

D0F0x64_x1F FCH Location

Reset: 0002_0001h.

Bits	Description																						
31:16	SBLocatedCore: Indicates which GPP Core has the FCH attached to it. Read-write. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000h</td><td>No FCH attached.</td></tr> <tr> <td>0001h</td><td>FCH located under PPD.</td></tr> <tr> <td>0002h</td><td>FCH located under SBG.</td></tr> <tr> <td>FFFFh-0003h</td><td>Reserved.</td></tr> </table>	Bits	Definition	0000h	No FCH attached.	0001h	FCH located under PPD.	0002h	FCH located under SBG.	FFFFh-0003h	Reserved.												
Bits	Definition																						
0000h	No FCH attached.																						
0001h	FCH located under PPD.																						
0002h	FCH located under SBG.																						
FFFFh-0003h	Reserved.																						
15:0	SBLocatedPort: Indicates which Port on the SBLocatedCore has the FCH. Read-write. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000h</td><td>No FCH attached.</td></tr> <tr> <td>0001h</td><td>FCH located on Port A of SBLocatedCore.</td></tr> <tr> <td>0002h</td><td>FCH located on Port B of SBLocatedCore.</td></tr> <tr> <td>0003h</td><td>Reserved.</td></tr> <tr> <td>0004h</td><td>FCH located on Port C of SBLocatedCore.</td></tr> <tr> <td>0007h-0005h</td><td>Reserved.</td></tr> <tr> <td>0008h</td><td>FCH located on Port D of SBLocatedCore.</td></tr> <tr> <td>000Fh-0009h</td><td>Reserved.</td></tr> <tr> <td>0010h</td><td>FCH located on Port E of SBLocatedCore.</td></tr> <tr> <td>FFFFh-0011h</td><td>Reserved.</td></tr> </table>	Bits	Definition	0000h	No FCH attached.	0001h	FCH located on Port A of SBLocatedCore.	0002h	FCH located on Port B of SBLocatedCore.	0003h	Reserved.	0004h	FCH located on Port C of SBLocatedCore.	0007h-0005h	Reserved.	0008h	FCH located on Port D of SBLocatedCore.	000Fh-0009h	Reserved.	0010h	FCH located on Port E of SBLocatedCore.	FFFFh-0011h	Reserved.
Bits	Definition																						
0000h	No FCH attached.																						
0001h	FCH located on Port A of SBLocatedCore.																						
0002h	FCH located on Port B of SBLocatedCore.																						
0003h	Reserved.																						
0004h	FCH located on Port C of SBLocatedCore.																						
0007h-0005h	Reserved.																						
0008h	FCH located on Port D of SBLocatedCore.																						
000Fh-0009h	Reserved.																						
0010h	FCH located on Port E of SBLocatedCore.																						
FFFFh-0011h	Reserved.																						

D0F0x64_x22 LCLK Control 0

Reset: 7F3F_8100h.

Bits	Description
31	Reserved.
30	SoftOverrideClk0. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the PCIe cores.
29	SoftOverrideClk1. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the internal graphics and the host response path.

28	SoftOverrideClk2. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host configuration requests.
27	SoftOverrideClk3. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the debug bus path.
26	SoftOverrideClk4. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the configuration block.
25	Reserved.
24	SoftOverrideClk6. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the VDM controller block.
23:0	Reserved.

D0F0x64_x23 LCLK Control 1

Reset: 7F3F_8100h.

Bits	Description
31	Reserved.
30	SoftOverrideClk0. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from all sources.
29	SoftOverrideClk1. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from the GPPFCH link core.
28	SoftOverrideClk2. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from internal graphics and its DMA response reordering path.
27	SoftOverrideClk3. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from internal graphics.
26	SoftOverrideClk4. Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from the Gfx link core.
25:0	Reserved.

D0F0x64_x3[4:0] Programmable Device Remap Register

Table 94: Reset values for [D0F0x64_x3\[4:0\]](#)

Register	Reset	Function
D0F0x64_x30	0000_0011h	Program [7:3]DevNum, [2:0]FnNum to map to PortA of PPD.
D0F0x64_x31	0000_0012h	Program [7:3]DevNum, [2:0]FnNum to map to PortB of PPD.
D0F0x64_x32	0000_0013h	Program [7:3]DevNum, [2:0]FnNum to map to PortC of PPD.
D0F0x64_x33	0000_0014h	Program [7:3]DevNum, [2:0]FnNum to map to PortD of PPD.
D0F0x64_x34	0000_0015h	Program [7:3]DevNum, [2:0]FnNum to map to PortE of PPD.

Software can only utilize device and function number combinations that are used by other (local) PCIe bridges. This effectively allows swapping of device and function numbers between bridges.

Bits	Description
31:8	Reserved.
7:0	DevFnMap. Read-write. Program [7:3]DevNum, [2:0]FnNum to map to PortA/B/C/D of each PCIe core.

D0F0x64_x46 IOC Features Control

Reset: 0001_1063h.

Bits	Description										
31:28	Reserved.										
27:24	Reserved.										
23	Reserved.										
22	Reserved.										
21:17	Reserved.										
16	CgctlLclkOverride . Read-write. BIOS: 0. Global bit to disable all LCLK gating branches.										
15:5	Reserved.										
4:3	Reserved.										
2:1	P2PMode: peer-to-peer mode . Read-write. Specifies how upstream write transactions above D0F0x64_x19 [Tom2] are completed. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.</td></tr> <tr> <td>01b</td><td>Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.</td></tr> <tr> <td>10b</td><td>Mode 2. Forward all writes to the host bridge0.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.	01b	Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.	10b	Mode 2. Forward all writes to the host bridge0.	11b	Reserved.
Bits	Definition										
00b	Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.										
01b	Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.										
10b	Mode 2. Forward all writes to the host bridge0.										
11b	Reserved.										
0	Reserved.										

D0F0x7C IOC Configuration Control

Cold reset: 0000_0000h.

Bits	Description
31:1	Reserved.
0	ForceIntGfxDisable: internal graphics disable . Read-write. Setting this bit disables the internal graphics and the HD Audio controller.

D0F0x84 Link Arbitration

Bits	Description
31:10	Reserved.
9	PmeTurnOff: PME_Turn_Off message trigger . Read-write. Reset: 0. 1=Trigger a PME_Turn_Off message to all downstream devices if PmeMode=1.
8	PmeMode: PME message mode . Read-write. Reset: 0. 1=PME_Turn_Off message is triggered by writing PmeTurnOff. 0=PME_Turn_Off message is triggered by a message from the FCH.
7:4	Reserved.

3	VgaHole: vga memory hole. Read-write. Reset: 1. This bit creates a hole in memory for the VGA memory range. 1=Requests hitting the VGA range are checked against PCI bridge memory ranges instead of being forwarded to system memory.
2:0	Reserved.

D0F0x90 Northbridge Top of Memory

Reset: 0000_0000h.

Bits	Description
31:23	TopOfDram. Read-write. BIOS: MSRC001_001A [TOM[31:23]]. Specifies the address that divides between MMIO and DRAM. From TopOfDram to 4G is MMIO; below TopOfDram is DRAM.
22:0	Reserved.

D0F0x94 Northbridge ORB Configuration Offset

Reset: 0000_0000h.

The index/data pair registers, [D0F0x94](#) and [D0F0x98](#), are used to access the registers at [D0F0x98_x](#)[FF:00]. To access any of these registers, the address is first written into the index register, [D0F0x94](#), and then the data is read from or written to the data register, [D0F0x98](#).

Bits	Description
31:7	Reserved.
6:0	OrbIndAddr: ORB index register address. Read-write.

D0F0x98 Northbridge ORB Configuration Data Port

See [D0F0x94](#). Address: [D0F0x94](#)[OrbIndAddr].

Bits	Description
31:0	OrbIndData: ORB index data register.

D0F0x98_x02 ORB PGMEM Control

Reset: 0000_0000h.

Bits	Description
31:16	PgmemHysteresis. Read-write. Hysteresis value for power-gating of ORB TX group of memories. Value represents absolute number of LCLK cycles.
15:8	Reserved.
7:5	TxPgmemStEn. Read-write. Power-gating enablement for the ORB TX group of memories. Bits are mutually exclusive. 7=SD (shutdown) mode. 6=DS (deep sleep) mode. 5=LS (light sleep) mode.
4:2	RxPgmemStEn. Read-write. Power-gating enablement for the ORB RX group of memories. Bits are mutually exclusive. 4=SD (shutdown) mode. 3=DS (deep sleep) mode. 2=LS (light sleep) mode.
1	OrbTxPgmemEn. Read-write. Enables ORB TX memory power-gating.
0	OrbRxPgmemEn. Read-write. Enables ORB RX memory power-gating.

D0F0x98_x06 ORB Downstream Control 0

Reset: 0000_0000h.

Bits	Description
31:27	Reserved.
26	UmiNpMemWrEn. Read-write. BIOS: See 2.11.4. 1=NP protocol over UMI for memory-mapped writes targeting LPC enabled. This bit may be set to avoid a deadlock condition.
25:0	Reserved.

D0F0x98_x07 ORB Upstream Arbitration Control 0

Reset: 0000_0080h.

Bits	Description						
31	SMUCsrIsocEn. Read-write. BIOS: 1. 1=CSR accesses go through ISOC channel. If this bit is set, D0F0x98_x1E[HiPriEn] must also be set.						
30:17	Reserved.						
16	SyncFloodOnParityErr. Read-write. Enable short circuit syncflood when arb_np detects a parity error for error containment.						
15	DropZeroMaskWrEn. Read-write. BIOS: 1. 1=Drop byte write request that have all bytes masked. 0=Forward byte write request that have all bytes masked.						
14:8	Reserved.						
7	IommuIsocPassPWMode. Read-write. BIOS: 1. 1=Always set PassPW for IOMMU upstream isochronous requests.						
6	DmaReqRespPassPWMode. Read-write. BIOS: 0. Specifies the RespPassPW bit for non-posted upstreamDMA requests. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>0</td><td>Always 1.</td></tr> <tr> <td>1</td><td>Value passed from IOC.</td></tr> </table>	Bit	Description	0	Always 1.	1	Value passed from IOC.
Bit	Description						
0	Always 1.						
1	Value passed from IOC.						
5	Reserved.						
4	IommuBwOptEn. Read-write. BIOS: 1. 1=Optimize IOMMU L2 byte write by detecting consecutive DW mask and translate the request to DW write.						
3	Reserved.						
2	IocRdROMapDis. Read-write. 1=Disable mapping relax ordering bit to RdRespPpw bit for IOC reads.						
1	IocWrROMapDis. Read-write. 1=Disables mapping relax ordering bit to PassPw bit for IOC writes.						
0	IocBwOptEn. Read-write. BIOS: 1. 1=Enable optimization of byte writes by detecting consecutive DW masks and translating the request to DW writes.						

D0F0x98_x08 ORB Upstream Arbitration Control 1

This register specifies the weights of the weighted round-robin arbiter in stage 1 of the upstream arbitration for

non-posted reads.

Bits	Description
31:24	NpWrrLenD . Read-write. Reset: 8h. BIOS: 8h. This field defines the maximum number of non-posted read requests from the SPG that are serviced before the arbiter switches to the next client.
23:16	NpWrrLenC . Read-write. Reset: 8h. BIOS: 1h. This field defines the maximum number of non-posted read requests from the SMU that are serviced before the arbiter switches to the next client.
15:8	NpWrrLenB . Read-write. Reset: 8h. BIOS: 8h. This field defines the maximum number of non-posted read requests from IOMMU that are serviced before the arbiter switches to the next client.
7:0	NpWrrLenA . Read-write. Reset: 8h. BIOS: 8h. This field defines the maximum number of non-posted read requests from IOC that are serviced before the arbiter switches to the next client.

D0F0x98_x09 ORB Upstream Arbitration Control 2

Reset: 0000_0808h.

This register specifies the weights of the weighted round-robin arbiter in stage 1 of the upstream arbitration for posted writes.

Bits	Description
31:24	Reserved.
23:16	PWrrLenC . Read-write. This field defines the maximum number of posted write requests from the SPG that are serviced before the arbiter switches to the next client.
15:8	PWrrLenB . Read-write. This field defines the maximum number of posted write requests from the IOMMU that are serviced before the arbiter switches to the next client.
7:0	PWrrLenA . Read-write. This field defines the maximum number of posted write requests from the IOC that are serviced before the arbiter switches to the next client.

D0F0x98_x0C ORB Upstream Arbitration Control 5

Reset: 0000_0808h. This register specifies the weights of the weighted round-robin arbiter in stage 2 of the upstream arbitration.

Bits	Description
31:24	Reserved.
23:16	Reserved.

15:8	GcmWrrLenB . Read-write. BIOS: 08h. This field defines the maximum number of non-posted read requests from stage 1 that are getting serviced in the round-robin before the stage 2 arbiter switches to the next client.
7:0	GcmWrrLenA . Read-write. BIOS: 08h. This field defines the maximum number of posted write requests from stage 1 that are getting serviced in the round-robin before the stage 2 arbiter switches to the next client.

D0F0x98_x1E ORB Receive Control 0

Reset: 4800_0000h.

Bits	Description
31:24	RxErrStatusDelay . Read-write. BIOS: 48h. Delay error status by number of LCLK cycles to filter false errors caused by reset skew.
23:2	Reserved.
1	HiPriEn . Read-write. BIOS: 1. 1=High priority channel enabled. See D0F0x98_x27[UrRedirectAddr[31:6]] . IF (D0F0x98_x1E[HiPriEn] ==0) THEN (D0F0x98_x07[SMUCsrIsocEn] ==0). IF (D0F0x98_x1E[HiPriEn] ==1) THEN (D18F0x[E4,C4,A4,84][IsocEn] ==1) in order to fully enable the Isoc channel on the ONION Link.
0	Reserved.

D0F0x98_x26 ORB IOMMU Control 0

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	UrRedirectAddr[39:32] . Read-write. See: D0F0x98_x27[UrRedirectAddr[31:6]] .

D0F0x98_x27 ORB IOMMU Control 1

Reset: 0000_0000h.

Bits	Description
31:6	UrRedirectAddr[31:6] . Read-write. BIOS: UrRedirectAddr[39:6] must be programmed to a safe system memory address when D0F2x44[IommuEnable] =1 . UrRedirectAddr[39:6] = { D0F0x98_x26[UrRedirectAddr[39:32]] , UrRedirectAddr[31:6]}. IOMMU requests that are not directed to system memory are redirected to UrRedirectAddr.
5:0	Reserved.

D0F0x98_x28 ORB Transmit Control 0

Reset: 0000_0002h.

Bits	Description
31:2	Reserved.
1	ForceCoherentIntr. Read-write. BIOS: 1. 1=Interrupt request are forced to have coherent bit set.
0	Reserved.

D0F0x98_x29 ORB Transmit Status

Reset: 0000_0000h.

Bits	Description
31:1	Reserved.
0	HostRdRespCrsDetected. Read; write-1-to-clear. 1= A host read response of type CRS was detected.

D0F0x98_x2C ORB Clock Control

Reset: 000F_0204h.

Bits	Description
31:16	WakeHysteresis. Read-write. BIOS: 19h. Specifies the amount of time hardware waits after ORB becomes idle before deasserting the wake signal to the NB. Wait time = WakeHysteresis * 200ns. Changes to this field should be done prior to setting DynWakeEn.
15:10	Reserved.
9	SBDmaActiveMask. Read-write. BIOS: 1. 0=SB_DMA_ACTIVE_L state affects OnInbWake state. 1= SB_DMA_ACTIVE_L state is masked out.
8:3	Reserved.
2	CgctlLclkOverride. Read-write. BIOS: 0h. Global bit to disable all LCLK gating branches in the ORB.
1	DynWakeEn. Read-write. BIOS: 1. 1=Enable dynamic toggling of the wake signal between ORB and NB. 0=Disable dynamic toggling of the wake signal. See WakeHysteresis.
0	Reserved.

D0F0x98_x37 ORB Allow LDTSTOP Control 0

Reset: 0020_0000h.

Bits	Description
31:28	Reserved.
27:16	LDTStopHystersis. Read-write. Specifies the number of timer periods (200 ns) the AllowLDTStop signal is held low before ORB asserts the signal again.
15:2	Reserved.

1	DmaActiveOutEn. Read-write. 1=Enable ORB to drive the DMAACTIVE_L pin. Meaningful only when D0F0x98_x37[AllowLDTStopPinMode] ==0.
0	AllowLDTStopPinMode. Read-write. Indicates the definition of the ALLOW_LDTSTOP pin. 0=Pin is used as DMAACTIVE_L. 1=Pin is used as ALLOW_LDTSTOP.

D0F0x98_x3A ORB Source Tag Translation Control 2

Reset: 0000_0000h.

Bits	Description
31:0	ClumpingEn. Read-write. BIOS should follow the below requirements. Valid only for GBIF client clumping; internal unit ID range 14h-17h. Legal GBIF clumping settings are: [23:20]=0010b, 0110b and 1110b which are applicable in any system configuration. 1110b is the recommended value. All other bits of this register must always remain 0. See D18F0x[11C,118,114,110] .

D0F0x98_x3B ORB Source Tag Translation Control 3

Reset: 0000_0000h.

Bits	Description
31:0	IocOutstandingMask. Read-write. Limit number of outstanding requests for very dma client via the IOC.

D0F0x98_x4[A,9] ORB LCLK Clock Control 1-0

Reset: 7F3F_8100h.

Bits	Description
31	Reserved.
30	SoftOverrideClk0. Read-write. BIOS: 0. See SoftOverrideClk6 .
29	SoftOverrideClk1. Read-write. BIOS: 0. See SoftOverrideClk6 .
28	SoftOverrideClk2. Read-write. BIOS: 0. See SoftOverrideClk6 .
27	SoftOverrideClk3. Read-write. BIOS: 0. See SoftOverrideClk6 .
26	SoftOverrideClk4. Read-write. BIOS: 0. See SoftOverrideClk6 .

25	SoftOverrideClk5. Read-write. BIOS: 0. See SoftOverrideClk6.
24	SoftOverrideClk6. Read-write. BIOS: 0. 1=Clock gating disabled. 0=Clock gating enabled.
23:0	Reserved.

D0F0xB8 SMU Index Address

The index/data pair registers, [D0F0xB8](#) and [D0F0xBC](#), are used to access the registers at [D0F0xBC_x\[FFFFFFFF:00000000\]](#). To access any of these registers, the address is first written into the index register, [D0F0xB8](#), and then the data is read from or written to the data register, [D0F0xBC](#).

Bits	Description
31:0	NbSmuIndAddr: smu index address. Read-write. Reset: 0.

D0F0xBC SMU Index Data

See [D0F0xB8](#). Address: [D0F0xB8](#)[NbSmuIndAddr].

Bits	Description
31:0	NbSmuIndData: smu index data. Reset: 0.

D0F0xBC_x3F800 FIRMWARE_FLAGS

Reset: xxxx_xxxxh.

Bits	Description						
31:24	TestCount. Read-write. Test count.						
23:1	Reserved.						
0	InterruptsEnabled. Read-write. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC.</td></tr> <tr> <td>1</td><td>Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC.</td></tr> </table>	Bits	Definition	0	Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC.	1	Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC.
Bits	Definition						
0	Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC.						
1	Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC.						

D0F0xBC_x3F804 FIRMWARE_VID

Reset: xxxx_xxxxh.

Bits	Description
7:0	FirmwareVid. Read-write. Current voltage set by firmware voltage controller.

D0F0xBC_x3F820 PM_INTERVAL_CNTL_0

Reset: xxxx_xxxxh.

Bits	Description
31:24	Loadline. Read-write.
23:16	VoltageCntl. Read-write.
15:8	ThermalCntl. Read-write.
7:0	LclkDpm. Read-write.

D0F0xBC_x3F828 PM_TIMER_PERIOD

Bits	Description
31:0	TimerPeriod. Read-write. Reset: X. Specifies the period at which various power management related algorithms are run. Period = TimerPeriod / REFCLK.

D0F0xBC_x3F9D8 PM_CONFIG

Reset: xxxx_xxxxh.

Bits	Description						
31:30	Reserved.						
29	SviMode. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0</td><td>SVI1.</td></tr> <tr> <td>1</td><td>SVI2.</td></tr> </table>	Bits	Description	0	SVI1.	1	SVI2.
Bits	Description						
0	SVI1.						
1	SVI2.						
28	BapmCoeffOverride. Read-write.						
27	NbPstateAllCpusIdle. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0</td><td>Use low NB P-state voltage when AllCpusIdle.</td></tr> <tr> <td>1</td><td>Use high NB P-state voltage when AllCpusIdle.</td></tr> </table>	Bits	Description	0	Use low NB P-state voltage when AllCpusIdle.	1	Use high NB P-state voltage when AllCpusIdle.
Bits	Description						
0	Use low NB P-state voltage when AllCpusIdle.						
1	Use high NB P-state voltage when AllCpusIdle.						
26:24	PstateAllCpusIdle. Read-write.						
23:6	Reserved.						
5	EnableNbDpm. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0</td><td>Disable Dynamic NB Pstate Management. Should be cleared before sending message to SMU.</td></tr> <tr> <td>1</td><td>Enable Dynamic NB Pstate Management. Should be set before sending BIOSMC_MSG_NBDPM_Enable message to SMU.</td></tr> </table>	Bits	Description	0	Disable Dynamic NB Pstate Management. Should be cleared before sending message to SMU.	1	Enable Dynamic NB Pstate Management. Should be set before sending BIOSMC_MSG_NBDPM_Enable message to SMU.
Bits	Description						
0	Disable Dynamic NB Pstate Management. Should be cleared before sending message to SMU.						
1	Enable Dynamic NB Pstate Management. Should be set before sending BIOSMC_MSG_NBDPM_Enable message to SMU.						
4	Reserved.						
3	EnableLpmx. Read-write.						
2	EnableTdcLimit. Read-write.						

1	EnableBapm. Read-write.
0	EnableVpcAccumulators. Read-write.

D0F0xBC_x3F9E8 NB_DPM_CONFIG_1

Reset: xxxx_xxxxh.

Bits	Description										
31:24	DpmXNbPsHi. Read-write. See: Dpm0PgNbPsLo.										
23:16	DpmXNbPsLo. Read-write. See: Dpm0PgNbPsLo.										
15:8	Dpm0PgNbPsHi. Read-write. See: Dpm0PgNbPsLo.										
7:0	Dpm0PgNbPsLo. Read-write. Indexes the NB P-state used during specific levels of GPU activity. See 2.5.4.1 [NB P-states]. <table> <tr> <th>Bits</th><th>NB P-state Indexed</th></tr> <tr> <td>00b</td><td>D18F3x160 (see D18F5x16[C:0]).</td></tr> <tr> <td>01b</td><td>D18F3x164 (see D18F5x16[C:0]).</td></tr> <tr> <td>10b</td><td>D18F3x168 (see D18F5x16[C:0]).</td></tr> <tr> <td>11b</td><td>D18F3x16C (see D18F5x16[C:0]).</td></tr> </table>	Bits	NB P-state Indexed	00b	D18F3x160 (see D18F5x16[C:0]).	01b	D18F3x164 (see D18F5x16[C:0]).	10b	D18F3x168 (see D18F5x16[C:0]).	11b	D18F3x16C (see D18F5x16[C:0]).
Bits	NB P-state Indexed										
00b	D18F3x160 (see D18F5x16[C:0]).										
01b	D18F3x164 (see D18F5x16[C:0]).										
10b	D18F3x168 (see D18F5x16[C:0]).										
11b	D18F3x16C (see D18F5x16[C:0]).										

D0F0xBC_x3F9EC NB_DPM_CONFIG_2

Reset: xxxx_xxxxh.

Bits	Description
31:25	Reserved.
24	EnableNbPsi1. Read-write. Specifies how PSI1_L functions for VDDNB. 0=PSI1_L is deasserted. 1=PSI1_L is asserted whenever the GPU is idle.
23:17	Reserved.
16	SkipDPM0. Read-write. Specifies whether SMU waits for SCLK DPM to transition to state 0 before transitioning NB to the NB P-states indexed Dpm0PgNbPsHi and Dpm0PgNbPsLo. 0=Wait for SCLK DPM state 0. 1=Do not wait for SCLK DPM state 0. See 2.5.4.1 [NB P-states].
15:9	Reserved.
8	SkipPG. Read-write. Specifies whether SMU waits for the GPU to be power gated before transitioning NB to the NB P-states indexed Dpm0PgNbPsHi and Dpm0PgNbPsLo. 0=Wait for GPU power gating. 1=Do not wait for GPU power gating. See 2.5.4.1 [NB P-states].
7:0	Hysteresis. Read-write. Specifies the time the GPU must be idle before transitioning to the NB P-states indexed by Dpm0PgNbPsHi and Dpm0PgNbPsLo.

D0F0xBC_x3F9F4 CSR_GNB_1

Bits	Description
31:24	SviTrimValueVddNB. Read-write. Reset: x. BIOS: D18F5x188[NbLoadLineTrim].

23:16	SviTrimValueVdd . Read-write. Reset: x. BIOS: D18F5x12C [CoreLoadLineTrim].
15:0	Reserved.

D0F0xBC_x3F9F8 CSR_GNB_3

Reset: xxxx_xxxxh.

Bits	Description
31:16	Reserved.
15:8	SviLoadLineOffsetVddNB . Read-write. Reset: x. BIOS: D18F5x188 [NbOffsetTrim].
7:0	SviLoadLineOffsetVdd . Read-write. Reset: x. BIOS: D18F5x12C [CoreOffsetTrim].

D0F0xBC_x3FD[8C:00:step14] LCLK DPM Control 0

Reset: xxxx_xxxxh. See [2.5.6.1.3 \[LCLK DPM\]](#). Each register in [D0F0xBC_x3FD\[8C:00:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 95: [Register Mapping](#) for [D0F0xBC_x3FD\[8C:00:step14\]](#)

Register	Function	Register	Function
D0F0xBC_x3FD00	State 0	D0F0xBC_x3FD50	State 4
D0F0xBC_x3FD14	State 1	D0F0xBC_x3FD64	State 5
D0F0xBC_x3FD28	State 2	D0F0xBC_x3FD78	State 6
D0F0xBC_x3FD3C	State 3	D0F0xBC_x3FD8C	State 7

Bits	Description
31:24	StateValid . Read-write. 1=DPM state is valid. 0=DPM state is invalid.
23:16	LclkDivider . Read-write. Specifies the LCLK divisor for this DPM state.
15:8	VID . Read-write. Specifies the VDDNB VID for this DPM state.
7:0	LowVoltageReqThreshold . Read-write.

D0F0xBC_x3FD[94:08:step14] LCLK DPM Control 2

Reset: xxxx_xxxxh. Each register in [D0F0xBC_x3FD\[94:08:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 96: [Register Mapping](#) for [D0F0xBC_x3FD\[94:08:step14\]](#)

Register	Function	Register	Function
D0F0xBC_x3FD08	State 0	D0F0xBC_x3FD58	State 4
D0F0xBC_x3FD1C	State 1	D0F0xBC_x3FD6C	State 5
D0F0xBC_x3FD30	State 2	D0F0xBC_x3FD80	State 6
D0F0xBC_x3FD44	State 3	D0F0xBC_x3FD94	State 7

Bits	Description
31:16	ResidencyCounter . Read-write.

15:8	HysteresisUp. Read-write.
7:0	HysteresisDown. Read-write.

D0F0xBC_x3FD[9C:10:step14] LCLK DPM Activity Thresholds

Reset: xxxx_xxxxh. Each register in [D0F0xBC_x3FD\[9C:10:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 97: [Register Mapping](#) for [D0F0xBC_x3FD\[9C:10:step14\]](#)

Register	Function	Register	Function
D0F0xBC_x3FD10	State 0	D0F0xBC_x3FD60	State 4
D0F0xBC_x3FD24	State 1	D0F0xBC_x3FD74	State 5
D0F0xBC_x3FD38	State 2	D0F0xBC_x3FD88	State 6
D0F0xBC_x3FD4C	State 3	D0F0xBC_x3FD9C	State 7

Bits	Description
31:24	ActivityThreshold. Read-write.
23:16	EnabledForThrottle. Read-write.
15:0	Reserved.

D0F0xBC_x3FDC8 SMU_LCLK_DPM_CNTL

Reset: xxxx_xxxxh.

Bits	Description
31:24	LclkDpmEn. Read-write. 1b=Enable LCLK DPM
23:16	VoltageChgEn. Read-write. 1=Enable voltage change during LCLK DPM state transition.
15:8	LclkDpmBootState. Read-write.
7:0	Reserved.

D0F0xBC_x3FDD0 SMU_LCLK_DPM_THERMAL_THROTTLING_CNTL

Reset: xxxx_xxxxh.

Bits	Description
31:24	TtHtcActive. Read-write.
23:16	LclkTtMode. Read-write.
15:8	TemperatureSel. Read-write.
7:0	LclkThermalThrottlingEn. Read-write.

D0F0xBC_x3FDD4 SMU_LCLK_DPM_THERMAL_THROTTLING_THRESHOLDS

Reset: xxxx_xxxxh.

Bits	Description
31:16	HighThreshold. Read-write. Specifies the high thermal threshold for LCLK thermal throttling.
15:0	LowThreshold. Read-write. Specifies the low thermal threshold for LCLK thermal throttling.

D0F0xBC_xC020_008C LCLK_DEEP_SLEEP_CNTL

Bits	Description																		
31:3	Reserved.																		
2:0	DivId. Read-write. Reset: 5. BIOS: 100b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Clock OFF</td></tr> <tr> <td>001b</td><td>Divide by 2</td></tr> <tr> <td>010b</td><td>Divide by 4</td></tr> <tr> <td>011b</td><td>Divide by 8</td></tr> <tr> <td>100b</td><td>Divide by 16</td></tr> <tr> <td>101b</td><td>Divide by 32</td></tr> <tr> <td>110b</td><td>Reserved</td></tr> <tr> <td>111b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	Clock OFF	001b	Divide by 2	010b	Divide by 4	011b	Divide by 8	100b	Divide by 16	101b	Divide by 32	110b	Reserved	111b	Reserved
Bits	Description																		
000b	Clock OFF																		
001b	Divide by 2																		
010b	Divide by 4																		
011b	Divide by 8																		
100b	Divide by 16																		
101b	Divide by 32																		
110b	Reserved																		
111b	Reserved																		

D0F0xBC_xC020_0098 CONNECTED_STANDBY_CONTROL

Bits	Description
31:2	Reserved.
1	S0i3_HINT[1]. Read-write. Reset: 0.
0	S0i3_HINT[0]. Read-write. Reset: 0.

D0F0xBC_xC020_0110 Activity Monitor Control

Bits	Description												
31:11	Reserved.												
10	EnOrbDsCnt. Read-write. Reset: X. 1=Enable downstream counter.												
9	EnOrbUsCnt. Read-write. Reset: X. 1=Enable upstream counter.												
8	EnBifCnt. Read-write. Reset: X. 1=Enable BIF counter.												
7:5	Reserved.												
4:3	BusyCntSel. Read-write. Reset: 0. Specifies subcomponents or activity monitored by the LCLK activity monitor. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>GFX DMA (BIF)</td><td>10b</td><td>Downstream activity</td></tr><tr><td>01b</td><td>Upstream activity</td><td>11b</td><td>Up/downstream activity max</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	GFX DMA (BIF)	10b	Downstream activity	01b	Upstream activity	11b	Up/downstream activity max
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	GFX DMA (BIF)	10b	Downstream activity										
01b	Upstream activity	11b	Up/downstream activity max										
2	Reserved.												
1	PeriodCntRst. Read-write. Reset: X.												
0	ActivityCntRst. Read-write. Reset: X.												

D0F0xBC_xC210_0000 CPU Interrupt Request

See 2.13.1 [Software Interrupts].

Bits	Description
31:17	Reserved.
16:1	ServiceIndex . Read-write. Reset: 0.
0	IntToggle . Read-write. Reset: 0.

D0F0xBC_xC210_0004 CPU Interrupt Status

See 2.13.1 [Software Interrupts].

Bits	Description
31:2	Reserved.
1	IntDone . Read-only; updated-by-hardware. Reset: 0.
0	IntAck . Read-only; updated-by-hardware. Reset: 0.

D0F0xBC_xC210_003C CPU Interrupt Argument

See 2.13.1 [Software Interrupts].

Bits	Description
31:0	Argument . Read-write. Reset: 0. Optional argument for a software interrupt.

D0F0xBC_xC210_0040 CPU Interrupt Response

See 2.13.1 [Software Interrupts].

Bits	Description
31:0	Argument . Read-write. Reset: 0. Optional response data upon completing a software interrupt.

D0F0xC8 DEV Index Address

The index/data pair registers, [D0F0xC8](#) and [D0F0xCC](#) are used to access the registers at [D0F0xCC_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0xC8](#), and then the data is read from or written to the data register, [D0F0xCC](#). Specific IOC bridges (Device/Function) are selected using the [D0F0xC8\[NbDevIndSel\]](#) field and enumerated as *_ib[15:11]* in the indexed register's mnemonic.

Bits	Description			
31:24	Reserved.			
23:16	NbDevIndSel: Device selector. Read-write. Reset: 0.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	10h-00h	Reserved	15h	D2F5
	11h	D2F1	FFh-16h	Reserved
	12h	D2F2		
	13h	D2F3		
	14h	D2F4		

15:7	Reserved.
6:0	NbDevIndAddr: Bridge (Device) index address. Read-write. Reset: 0.

D0F0xCC DEV Index Data

See [D0F0xC8](#). Address: [D0F0xC8](#)[NbDevIndAddr].

Bits	Description
31:0	NbDevIndData: dev index data.

D0F0xCC_x01_ib[15:11] IOC Bridge Control

Reset: 0000_0000h.

Bits	Description
31:24	ApicRange. Read-write. Sets the bridge APIC range.
23	ApicEnable. Read-write. 1=Enables the bridge APIC range decoding. Requests fall in bridge APIC range if addr[39:12]={20'h00_FEC, APIC_Range[7:0]}.
22:21	Reserved.
20	SetPowEn. Read-write. 1=Enable generation of set_slot_power message to the bridge.
19	Reserved.
18	CrsEnable. Read-write. 1=Enables the hardware retry on receiving configuration request retry status.
17	ExtDevCrsEn. Read-write. 1=Reset the bridge CRS counter when an external device is plugged in or the link is down.
16	ExtDevPlug. Read-write. 1=Indicates to IOC that an external device is being plugged on the bridge.
15:4	Reserved.
3	P2pDis. Read-write. 1=Disables local peer-to-peer transactions forwarded to this bridge.
2	CfgDis. Read-write. 1=Configuration accesses to this bridge are disabled. Non-FCH bridges are not expected to set this bit.
1	BusMasterDis. Read-write. 1=The bridge's ability to operate as a bus master is disabled. This overrides the Bus Master Enable bit in the bridge.
0	BridgeDis. Read-write. 1=The bridge is hidden and no accesses are allowed to this bridge.

D0F0xD0 GBIF Index Address

The index/data pair registers, [D0F0xD0](#) and [D0F0xD4](#) are used to access the registers at [D0F0xD4_x\[FFFF_FFFF:0000_0000\]](#). To access any of these registers, the address is first written into the index register, [D0F0xD0](#), and then the data is read from or written to the data register, [D0F0xD4](#).

Bits	Description
31:0	NbGbifIndAddr: Gbif index address. Read-write. Reset: 0.

D0F0xD4 GBIF Index Data

See [D0F0xD0](#). Address: [D0F0xD0](#)[NbGbifIndAddr].

Bits	Description
31:0	NbGbifIndData: Gbif index data. Reset: 0.

D0F0xD4_x0109_14E1 CC Bif Bx Strap0 Ind

Reset: 0000_C004h.

Bits	Description										
31:13	Reserved.										
12	StrapBifDoorbellBarDis. Read-write.										
11:6	Reserved.										
5:3	StrapBifMemApSize. Read-write. Size of the primary memory apertures claimed in the PCI configuration space. The aperture size should be rounded to the next power of 2 size (up to 128MB) as the frame buffer for frame buffers smaller than 128MB. For frame buffers larger than 128 MB the aperture size should be set to 256 MB. See D0F0xD4_x0109_1507 [StrapBifMemApSizePin]. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>128 MB</td></tr> <tr> <td>001b</td><td>256 MB</td></tr> <tr> <td>010b</td><td>64 MB</td></tr> <tr> <td>111b-011b</td><td>Reserved</td></tr> </table>	Bits	Definition	000b	128 MB	001b	256 MB	010b	64 MB	111b-011b	Reserved
Bits	Definition										
000b	128 MB										
001b	256 MB										
010b	64 MB										
111b-011b	Reserved										
2:1	StrapBifRegApSize. Read-write. Specifies the register aperture size. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>64 MB</td></tr> <tr> <td>01b</td><td>128 MB</td></tr> <tr> <td>10b</td><td>256 MB</td></tr> <tr> <td>11b</td><td>512 MB</td></tr> </table>	Bits	Definition	00b	64 MB	01b	128 MB	10b	256 MB	11b	512 MB
Bits	Definition										
00b	64 MB										
01b	128 MB										
10b	256 MB										
11b	512 MB										
0	Reserved.										

D0F0xD4_x0109_14E2 CC Bif Bx Strap1 Ind

Reset: 0000_0000h.

Bits	Description
31:14	Reserved.
13	Reserved.
12:11	Reserved.
10	Reserved.
9	Reserved.
8	Reserved.
7:4	Reserved.
3	StrapBifF064BarDisA. Read-write.
2	Reserved.
1	StrapBifIoBarDis. Read-write.
0	Reserved.

D0F0xD4_x0109_1507 CC Bif Bx Pinstrap0 Ind

Reset: 0000_0802h.

Bits	Description
31:17	Reserved.
16	Reserved.
15:8	Reserved.
7:5	StrapBifMemApSizePin. Read-write. See: D0F0xD4_x0109_14E1 [StrapBifMemApSize]
4:0	Reserved.

D0F0xE0 Link Index Address

Reset: 0130_8001h.

[D0F0xE0](#) and [D0F0xE4](#) are used to access [D0F0xE4_x\[FFFF_FFFF:0000_0000\]](#). To read or write to one of these register, the address is written first into the address register [D0F0xE0](#) and then the data is read from or written to the data register [D0F0xE4](#).

The phy index registers ([D0F0xE4_x0\[2:1\]xxx_xxxx](#)) mapping to a specific phy, pin or pin group is shown in a table in the register definition. For example, to perform a read or write operation to configure Gfx phy 0 (P_GFX_[T,R]X[P,N][7:0] pin group) compensation, software should program [D0F0xE0](#)[31:0]=0120_0000h. Accessing any register number that is not listed in the mapping table may result in undefined behavior.

Some phy registers support broadcast write operations to groups of 4 or 8 lanes. For example, to perform broadcast write operation to configure Gfx Link[3:0] (P_GFX_RX[P,N][3:0] lanes) receiver phase loop filter, software should program [D0F0xE0](#)[31:0]=0120_5602h.

Bits	Description												
31:24	BlockSelect: block select. Read-write. This field is used to select the specific register block to access. The encodings supported depends on the FrameType selected. <table> <tr> <td><u>FrameType</u></td><td><u>Encoding</u></td></tr> <tr> <td>01h</td><td>1=GPP link core</td></tr> <tr> <td>10h</td><td>1=Phy interface 0</td></tr> <tr> <td>20h</td><td>1=Phy 0</td></tr> <tr> <td>30h</td><td>1=Wrapper</td></tr> <tr> <td>40h</td><td>1=IO link core</td></tr> </table>	<u>FrameType</u>	<u>Encoding</u>	01h	1=GPP link core	10h	1=Phy interface 0	20h	1=Phy 0	30h	1=Wrapper	40h	1=IO link core
<u>FrameType</u>	<u>Encoding</u>												
01h	1=GPP link core												
10h	1=Phy interface 0												
20h	1=Phy 0												
30h	1=Wrapper												
40h	1=IO link core												
23:16	FrameType: frame type. Read-write. This field is used to select the type of register block to access. <table> <tr> <td><u>Bits</u></td><td><u>Destination</u></td></tr> <tr> <td>10h</td><td>GPP Phy interface block registers.</td></tr> <tr> <td>20h</td><td>GPP Phy registers.</td></tr> <tr> <td>30h</td><td>GPP Wrapper registers.</td></tr> <tr> <td>40h</td><td>GPP IO Link registers.</td></tr> </table>	<u>Bits</u>	<u>Destination</u>	10h	GPP Phy interface block registers.	20h	GPP Phy registers.	30h	GPP Wrapper registers.	40h	GPP IO Link registers.		
<u>Bits</u>	<u>Destination</u>												
10h	GPP Phy interface block registers.												
20h	GPP Phy registers.												
30h	GPP Wrapper registers.												
40h	GPP IO Link registers.												
15:0	PcieIndxAddr: index address. Read-write.												

D0F0xE4 Link Index Data

See [D0F0xE0](#). Address: {[D0F0xE0](#)[BlockSelect],[D0F0xE0](#)[FrameType],[D0F0xE0](#)[PcieIndxAddr]}.

Bits	Description
31:0	PcieIndxData: index data.

3.3.1 PIF Registers**D0F0xE4_x0110_0010 PIF Control**

Reset: 3190_44D8h.

Bits	Description																				
31:20	Reserved.																				
19:17	Ls2ExitTime: LS2 exit time. Read-write. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>14us</td><td>100b</td><td>30us</td></tr><tr><td>001b</td><td>10us</td><td>101b</td><td>100ns</td></tr><tr><td>010b</td><td>15us</td><td>110b</td><td>100us</td></tr><tr><td>011b</td><td>20us</td><td>111b</td><td>50us</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	14us	100b	30us	001b	10us	101b	100ns	010b	15us	110b	100us	011b	20us	111b	50us
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	14us	100b	30us																		
001b	10us	101b	100ns																		
010b	15us	110b	100us																		
011b	20us	111b	50us																		
16:8	Reserved.																				
7	RxDetectTxPwrMode: receiver detection transmitter power mode. Read-write. 1=Transmitter is powered on.																				
6	RxDetectFifoResetMode: receiver detect FIFO reset mode. Read-write. BIOS: 1. 1=The transmit FIFO is reset after receiver detection. 0=The transmit FIFO is not reset after receiver detection.																				
5	Reserved.																				
4	EiDetCycleMode: electrical idle detect mode. Read-write. 1=Electrical idle cycle detection mode is enabled in L1. 0=Electrical idle detection is always enabled in L1.																				
3:0	Reserved.																				

D0F0xE4_x0110_0011 PIF Pairing

Reset: 0200_0000h.

Bits	Description
31:26	Reserved.
25	MultiPif: x16 link. Read-write. 1=Lanes 7:0 are paired with a second PIF to create a x16 link.
24:21	Reserved.
20	X16Lane150: x16 link lanes 15:0. Read-write. 1=Lanes 15:0 are paired to create a x16 link.
19:18	Reserved.
17	X8Lane158: x8 link lanes 15:8. Read-write. 1=Lanes 15:8 are paired to create a x8 link.
16	X8Lane70: x8 link lanes 7:0. Read-write. 1=Lanes 7:0 are paired to create a x8 link.
15:12	Reserved.
11	X4Lane1512: x4 link lanes 15:12. Read-write. 1=Lanes 15:12 are paired to create a x4 link.

10	X4Lane118: x4 link lanes 11:8. Read-write. 1=Lanes 11:8 are paired to create a x4 link.
9	X4Lane74: x4 link lanes 7:4. Read-write. 1=Lanes 7:4 are paired to create a x4 link.
8	X4Lane30: x4 link lanes 3:0. Read-write. 1=Lanes 3:0 are paired to create a x4 link.
7	X2Lane1514: x2 link lanes 15:14. Read-write. 1=Lanes 15:14 are paired to create a x2 link
6	X2Lane1312: x2 link lanes 13:12. Read-write. 1=Lanes 13:12 are paired to create a x2 link
5	X2Lane1110: x2 link lanes 11:10. Read-write. 1=Lanes 11:10 are paired to create a x2 link
4	X2Lane98: x2 link lanes 9:8. Read-write. 1=Lanes 9:8 are paired to create a x2 link
3	X2Lane76: x2 link lanes 7:6. Read-write. 1=Lanes 7:6 are paired to create a x2 link.
2	X2Lane54: x2 link lanes 5:4. Read-write. 1=Lanes 5:4 are paired to create a x2 link.
1	X2Lane32: x2 link lanes 3:2. Read-write. 1=Lanes 3:2 are paired to create a x2 link.
0	X2Lane10: x2 link lanes 1:0. Read-write. 1=Lanes 1:0 are paired to create a x2 link.

D0F0xE4_x0110_001[8:7,3:2] PIF Power Down Control [3:0]

Reset: 0001_1FA2h.

Table 98: Index addresses for [D0F0xE4_x0110_001\[8:7,3:2\]](#)

D0F0xE0[31:16]	D0F0xE0[15:0]			
	0018h	0017h	0013h	0012h
0110h	PIF Lanes 15-12	PIF Lanes 11-8	PIF Lanes 7-4	PIF Lanes 3-0

Bits	Description																				
31:29	PlIPwrOverrideVal: PLL power state override value. Read-write. See TxPowerStateInTx2.																				
28	PlIPwrOverrideEn: PLL power state override enable. Read-write. 1=PLL forced to the power state specified by PlIPwrOverrideVal.																				
27	Reserved.																				
26:24	PlIRampUpTime: PLL ramp time. Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>10 us</td><td>100b</td><td>50 us</td></tr><tr><td>001b</td><td>5 us</td><td>101b</td><td>300 us</td></tr><tr><td>010b</td><td>15 us</td><td>110b</td><td>500 us</td></tr><tr><td>011b</td><td>22 us</td><td>111b</td><td>800 us</td></tr></table>	Bits	Definition	Bits	Definition	000b	10 us	100b	50 us	001b	5 us	101b	300 us	010b	15 us	110b	500 us	011b	22 us	111b	800 us
Bits	Definition	Bits	Definition																		
000b	10 us	100b	50 us																		
001b	5 us	101b	300 us																		
010b	15 us	110b	500 us																		
011b	22 us	111b	800 us																		
23:17	Reserved.																				
16	Tx2p5clkClockGatingEn. Read-write. 1=The 2.5x TxClk is gated if the lane is idle 0=The 2.5x TxClk is never gated.																				
15:13	Reserved.																				
12:10	PlIPowerStateInOff: PLL off power state. Read-write. See: TxPowerStateInTx2. All links associated with the PLL must be in the off state to transition the PLL to this state.																				
9:7	PlIPowerStateInTx2: PLL L1 power state. Read-write. See: TxPowerStateInTx2. All links associated with the PLL must be in L1 to transition the PLL to this state.																				
6:4	RxPowerStateInRx2: receiver L1 power state. Read-write. See: TxPowerStateInTx2.																				

3	ForceRxEnInL0s: force receiver enable in L0s. Read-write. 1=The phy CDR is always enabled in L0s.			
2:0	TxPowerStateInTxs2: transmitter L1 power state. Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	L0	100b	Reserved
	001b	LS1	101b	Reserved
	010b	LS2	110b	Reserved
	011b	Reserved	111b	Off

3.3.2 Phy Registers

3.3.2.1 Global Phy Control Registers

D0F0xE4_x0120_0004 Phy Global Control 0

Bits	Description
31:18	Reserved.
17:16	CfgIdleDetTh. Read-write. Reset: 1. BIOS: 0. Idle detector threshold control
15:0	Reserved.

D0F0xE4_x0120_4440 Phy RO PLL Control

Bits	Description										
31:15	Reserved.										
14:13	PllDbgRoIPFDResetCntrl. Read-write. Reset: 0. BIOS: 2. PFD reset pulse width control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>PFD reset pulse width = 603 ps (@85C_tt)</td></tr> <tr> <td>01b</td><td>PFD reset pulse width = 190 ps (@85C_tt)</td></tr> <tr> <td>10b</td><td>PFD reset pulse width = 397 ps (@85C_tt)</td></tr> <tr> <td>11b</td><td>PFD reset pulse width = 82 ps (@85C_tt)</td></tr> </table>	Bits	Definition	00b	PFD reset pulse width = 603 ps (@85C_tt)	01b	PFD reset pulse width = 190 ps (@85C_tt)	10b	PFD reset pulse width = 397 ps (@85C_tt)	11b	PFD reset pulse width = 82 ps (@85C_tt)
Bits	Definition										
00b	PFD reset pulse width = 603 ps (@85C_tt)										
01b	PFD reset pulse width = 190 ps (@85C_tt)										
10b	PFD reset pulse width = 397 ps (@85C_tt)										
11b	PFD reset pulse width = 82 ps (@85C_tt)										
12:0	Reserved.										

D0F0xE4_x0120_4450 PhyRO PLL Override Control 0

Bits	Description						
31	Reserved.						
30	PllCfgROVTOIBiasCntrlOvrdVal0. Read-write. Reset: 1. BIOS: 0. Override value bit for CP_PLL_CFG_RO_VTOI_BIAS_CNTRL.						
29:8	Reserved.						
7:0	PllCfgROBWCntrlOvrdVal0. Read-write. Reset: 8Dh. BIOS: 90h. Override value bit for CP_PLL_CFG_RO_BW_CNTRL. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[7:3]</td><td>Proportional CP current setting</td></tr> <tr> <td>[2:0]</td><td>Integral CP current setting</td></tr> </table>	Bit	Definition	[7:3]	Proportional CP current setting	[2:0]	Integral CP current setting
Bit	Definition						
[7:3]	Proportional CP current setting						
[2:0]	Integral CP current setting						

3.3.3 Wrapper Registers

Table 99: Mapping for wrapper registers

D0F0xE0[31:16]	Wrapper	Port Description
0130h	PGD	GPP

D0F0xE4_x0130_0046 Subsystem and Vendor ID

Bits	Description
31:16	SubsystemID: subsystem id. Read-write. Reset: 1234h. Specifies the value returned by D2F[5:1]xB4[SubsystemID] .
15:0	SubsystemVendorID: subsystem vendor id . Read-write. Reset: 1022h. Specifies the value returned by D2F[5:1]xB4[SubsystemVendorID] .

D0F0xE4_x0130_0080 Link Configuration

Reset: 0000_0000h.

Bits	Description																				
31:4	Reserved.																				
3:0	StrapBifLinkConfig. Read-write; strap. Reset: Product-specific. BIOS: See Table 71 . <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>0000b</td><td>Reserved</td><td>0100b</td><td>4 x1 IO Links (GPPFCH Only)</td></tr><tr><td>0001b</td><td>x4 IO Link (GPPFCH Only)</td><td>0101b</td><td>Reserved</td></tr><tr><td>0010b</td><td>2 x2 IO Links (GPPFCH Only)</td><td>011xb</td><td>Reserved</td></tr><tr><td>0011b</td><td>1 x2 IO Link, 2 x1 IO Links (GPPFCH Only)</td><td>1xxxb</td><td>Reserved</td></tr></table>	Bits	Definition	Bits	Definition	0000b	Reserved	0100b	4 x1 IO Links (GPPFCH Only)	0001b	x4 IO Link (GPPFCH Only)	0101b	Reserved	0010b	2 x2 IO Links (GPPFCH Only)	011xb	Reserved	0011b	1 x2 IO Link, 2 x1 IO Links (GPPFCH Only)	1xxxb	Reserved
Bits	Definition	Bits	Definition																		
0000b	Reserved	0100b	4 x1 IO Links (GPPFCH Only)																		
0001b	x4 IO Link (GPPFCH Only)	0101b	Reserved																		
0010b	2 x2 IO Links (GPPFCH Only)	011xb	Reserved																		
0011b	1 x2 IO Link, 2 x1 IO Links (GPPFCH Only)	1xxxb	Reserved																		

D0F0xE4_x0130_0[C:8]00 Link Hold Training Control

Table 100: Index address mapping for [D0F0xE4_x0130_0\[C:8\]00](#)

Index	Function
0130_0800h	GPPSB PortA
0130_0900h	GPPSB PortB
0130_0A00h	GPPSB PortC
0130_0B00h	GPPSB PortD
0130_0C00h	GPPSB PortE

Bits	Description
31:1	Reserved.
0	HoldTraining: hold link training. Read-write. Reset: 1. 1=Hold training on link.

D0F0xE4_x0130_0[C:8]03 Link Deemphasis ControlTable 101: Index address mapping for [D0F0xE4_x0130_0\[C:8\]03](#)

Index	Function
0130_0803h	GPPSB PortA
0130_0903h	GPPSB PortB
0130_0A03h	GPPSB PortC
0130_0B03h	GPPSB PortD
0130_0C03h	GPPSB PortE

Bits	Description
31:6	Reserved.
5	StrapBifDeemphasisSel. Read-write; strap. Reset: 1. Controls the default value of D2F[5:1]x88[SelectableDeemphasis] . 1=RC advertises -3.5dB. 0=RC advertises -6dB.
4:0	Reserved.

D0F0xE4_x0130_0[C:8]04 Link AER Control

Bits	Description
31:4	Reserved.
3:1	StrapBifMaxPayloadSupport. Read-write; strap. Reset: 2h. BIOS: See 2.11.3.2 [Link Configurations] .
0	Reserved.

D0F0xE4_x0130_0[C:8]05 Link Training Control

Reset: 1800_0000h.

Table 102: Index address mapping for [D0F0xE4_x0130_0\[C:8\]05](#)

Index	Function
0130_0805h	GPPSB PortA
0130_0905h	GPPSB PortB
0130_0A05h	GPPSB PortC
0130_0B05h	GPPSB PortD
0130_0C05h	GPPSB PortE

Bits	Description
31:24	StrapBifInitialNFts. Read-write; strap. BIOS: 40h. Specifies the number of Fast Training Sets(FTS) transmitted. FTS are special packets transmitted to exit out of the PCIe L0s sleep state.
23:0	Reserved.

D0F0xE4_x0130_8002 IO Link Wrapper Scratch

Cold reset: 0000_0000h.

Bits	Description
31:0	PcieWrapScratch: Scratch. Read-write.

D0F0xE4_x0130_8011 Link Transmit Clock Gating Control

Bits	Description
31:26	Reserved.
25	Reserved.
24	TxclkLcntGateEnable. Read-write. Reset: 0. BIOS: 1. 1=Enable clock gating the lane counter.
23	DebugBusClkEnable. Read-write. Reset: 1. BIOS: 0. 1=Enable the debug bus clock.
22:17	TxclkPermGateLatency. Read-write. Reset: 3Fh. Specifies the number of clocks to wait after detecting an entry into L1 before gating off the permanent clock branches.
16	RcvrDetClkEnable. Read-write. Reset: 0. 1=Enable the receiver detect clock.
15:10	TxclkRegsGateLatency. Read-write. Reset: 3Fh. Specifies the number of clocks to wait after idle is signalled before gating off the register clock branch.
9	TxclkRegsGateEnable. Read-write. Reset: 0. BIOS: 1. 1=Enable clock gating the register clock.
8	TxclkPermStop. Read-write. Reset: 0. 1=All transmitter clocks disabled. This bit should only be set if all links associated with the PCIe core are unconnected.
7	TxclkDynGateEnable. Read-write. Reset: 0. BIOS: 1. 1=Dynamic clock gating enabled. 0=Dynamic clock gating disabled.
6	TxclkPermGateEven. Read-write. Reset: 1. 1=Gate the permanent clock branches for an even number of clocks.
5:0	TxclkDynGateLatency. Read-write. Reset: 3Fh. Specifies the number of clocks to wait after idle is signalled before gating off the dynamic clock branch.

D0F0xE4_x0130_8012 Link Idle-Resume Clock Gating Control

Bits	Description
31:14	Reserved.
13:8	Pif1xIdleResumeLatency. Read-write. Reset: 00_0111b. Specifies the number of clocks to wait after enabling TXCLK1X_PIF before sending the acknowledge.
7	Pif1xIdleGateEnable. Read-write. Reset: 0. BIOS: 1. 1=Enable idle resume gating of TXCLK1X_PIF.
6	Reserved.
5:0	Pif1xIdleGateLatency. Read-write. Reset: 0_0001b. Specifies the number of clocks to wait before turning off TXCLK1X_PIF.

D0F0xE4_x0130_8013 Transmit Clock PLL Control

Reset: 0000_0001h.

Bits	Description
31:15	Reserved.
14:13	PhyRxIsoDis. Read-write. 1=Isolate PHY signals to PIF.
12	Reserved.
11	Reserved.
10	TxclkSelPifBOverride. Read-write. 1=Override TxclkPifB selection.
9	TxclkSelPifAOverride. Read-write. 1=Override TxclkPifA selection.
8	TxclkSelCoreOverride. Read-write. 1=Override TxclkCore selection.
7	Reserved.
6	Reserved.
5	ClkDividerResetOverrideB. Read-write. 1=Force clock divider B enabled.
4	ClkDividerResetOverrideA. Read-write. 1=Force clock divider A enabled.
3	Reserved.
2	Reserved.
1	MasterPciePllB. Read-write. 1=Pll B is the master source for all PCIe transmitter clock branches.
0	MasterPciePllA. Read-write. 1=Pll A is the master source for all PCIe transmitter clock branches.

D0F0xE4_x0130_8014 Link Transmit Clock Gating Control 2

Reset: 0000_0000h.

Bits	Description
31:28	SpareRegRw. Read-write. Spare register.
27	Reserved.
26	Reserved.
25	Reserved.
24	Reserved.

23:21	Reserved.
20	TxclkPermGateOnlyWhenPlIPwrDn. Read-write. BIOS: 1. 1=Gating of the permanent clock branch only occurs when the PLL is powered down.
19:16	Reserved.
15	Reserved.
14	Reserved.
13	PcieGatePifB1xEnable. Read-write. BIOS: 1. 1=Enable gating of the PIF B 1x clock branches in PCIe mode.
12	PcieGatePifA1xEnable. Read-write. BIOS: 1. 1=Enable gating of the PIF A 1x clock branches in PCIe mode.
11:6	Reserved.
5	Reserved.
4	Reserved.
3	Reserved.
2	Reserved.
1	TxclkPrbsGateEnable. Read-write. BIOS: 1. 1=Enable gating of the PRBS clock branch.
0	TxclkPermGateEnable. Read-write. BIOS: 1. 1=Enable gating of the permanent clock branch.

D0F0xE4_x0130_8015 IO Link IOC Control

Bits	Description
31:24	Reserved.
23	RefclkRegsGateEnable. Read-write. Reset:0. BIOS: 1. 1=Enable gating of REFCLK_REGS.
22	Reserved.
21:16	RefclkRegsGateLatency. Read-write. Reset:3Fh. Specifies the number of clocks to wait before turning off REFCLK_REGS.
15:0	Reserved.

D0F0xE4_x0130_8016 Link Clock Switching Control

Reset: 003F_001Fh.

Bits	Description
31:24	Reserved.
23	LclkDynGateEnable. Read-write. 1=Enable LCLK_DYN clock gating.

22	LclkGateFree . Read-write. IF (REG== D0F0xE4_x013[1:0]_8016) THEN BIOS: 1. ENDIF. 1=LCLK gating is controlled independent of TXCLK gating.
21:16	LclkDynGateLatency . Read-write. Specifies the number of clocks to wait before turning off LCLK_DYN.
15:6	Reserved.
5:0	CalibAckLatency . Read-write. Specifies the number of clocks after calibration is complete before the acknowledge signal is asserted.

D0F0xE4_x0130_802[4:1] Transmitter Lane Mux

Table 103: Lane index addresses for [D0F0xE4_x0130_802\[4:1\]](#)

D0F0xE0[31:4]	D0F0xE0[3:0]			
	4h	3h	2h	1h
0130_802h	Lanes[15:12]	Lanes[11:8]	Lanes[7:4]	Lanes[3:0]

Table 104: Reset Mapping for [D0F0xE4_x0130_802\[4:1\]](#)

Register	Reset
D0F0xE4_x0130_8024	0F0E_0D0Ch
D0F0xE4_x0130_8023	0B0A_0908h
D0F0xE4_x0130_8022	0706_0504h
D0F0xE4_x0130_8021	0302_0100h

Table 105: Field mapping for [D0F0xE4_x0130_802\[4:1\]](#)

Register	Bits			
	31:24	23:16	15:8	7:0
D0F0xE4_x0130_8024	TXLane15	TXLane14	TXLane13	TXLane12
D0F0xE4_x0130_8023	TXLane11	TXLane10	TXLane9	TXLane8
D0F0xE4_x0130_8022	TXLane7	TXLane6	TXLane5	TXLane4
D0F0xE4_x0130_8021	TXLane3	TXLane2	TXLane1	TXLane0

Bits	Description
31:24	TXLane . Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: D0F0xE4_x0130_802[4:1][7:0] .
23:16	TXLane . Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: D0F0xE4_x0130_802[4:1][7:0] .

15:8	TXLane. Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: D0F0xE4_x0130_802[4:1][7:0] .			
7:0	TXLane. Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	Controller lane 0.	8h	Controller lane 8.
	1h	Controller lane 1.	9h	Controller lane 9.
	2h	Controller lane 2.	10h	Controller lane 10.
	3h	Controller lane 3.	11h	Controller lane 11.
	4h	Controller lane 4.	12h	Controller lane 12.
	5h	Controller lane 5.	13h	Controller lane 13.
	6h	Controller lane 6.	14h	Controller lane 14.
	7h	Controller lane 7.	15h	Controller lane 15.

D0F0xE4_x0130_802[8:5] Receiver Lane Mux

Reset: 0302_0100h.

Table 106: Lane index addresses for [D0F0xE4_x0130_802\[8:5\]](#)

D0F0xE0[31:4]	D0F0xE0[3:0]			
	8h	7h	6h	5h
0130_802h	Lanes[15:12]	Lanes[11:8]	Lanes[7:4]	Lanes[3:0]

Table 107: [Reset Mapping](#) for [D0F0xE4_x0130_802\[8:5\]](#)

Register	Reset
D0F0xE4_x0130_8028	0F0E_0D0Ch
D0F0xE4_x0130_8027	0B0A_0908h
D0F0xE4_x0130_8026	0706_0504h
D0F0xE4_x0130_8025	0302_0100h

Table 108: Field mapping for [D0F0xE4_x0130_802\[8:5\]](#)

Register	Bits			
	31:24	23:16	15:8	7:0
D0F0xE4_x0130_8028	RXLane15	RXLane14	RXLane13	RXLane12
D0F0xE4_x0130_8027	RXLane11	RXLane10	RXLane9	RXLane8
D0F0xE4_x0130_8026	RXLane7	RXLane6	RXLane5	RXLane4
D0F0xE4_x0130_8025	RXLane3	RXLane2	RXLane1	RXLane0

Bits	Description
31:24	RXLane. Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: D0F0xE4_x0130_802[8:5][7:0] .
23:16	RXLane. Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: D0F0xE4_x0130_802[8:5][7:0] .

15:8	RXLane . Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: D0F0xE4_x0130_802[8:5][7:0] .			
7:0	RXLane . Read-write. Specifies the PIF RX lanes that are mapped to controller lane n.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	PIF RX lane 0.	8h	PIF RX lane 8.
	1h	PIF RX lane 1.	9h	PIF RX lane 9.
	2h	PIF RX lane 2.	10h	PIF RX lane 10.
	3h	PIF RX lane 3.	11h	PIF RX lane 11.
	4h	PIF RX lane 4.	12h	PIF RX lane 12.
	5h	PIF RX lane 5.	13h	PIF RX lane 13.
	6h	PIF RX lane 6.	14h	PIF RX lane 14.
	7h	PIF RX lane 7.	15h	PIF RX lane 15.

D0F0xE4_x0130_8029 Lane Enable

Reset: 0000_FFFFh.

Bits	Description				
31:16	Reserved.				
15:0	LaneEnable . Read-write. 1=Lane enabled for transmit. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[15:0]</td><td>Lane <BIT> enable</td></tr> </table>	Bit	Definition	[15:0]	Lane <BIT> enable
Bit	Definition				
[15:0]	Lane <BIT> enable				

D0F0xE4_x0130_8060 Soft Reset Command 0

Cold reset: 0000_0000h.

Bits	Description
31:18	Reserved.
17	Bif0CalibrationReset . Read-write. 1=The BIF 0 calibration block reset is asserted.
16	Bif0GlobalReset . Read-write. 1=The BIF 0 global reset is asserted.
15:4	Reserved.
3	WaitState . Read-only. 1=Reset cycle is in the wait state.
2	ResetComplete . Read-only. 1=Reset cycle is complete.
1	Reserved.
0	Reconfigure . Read-write; Cleared-when-done. 1=Trigger atomic reconfiguration if D0F0xE4_x0130_8062[ReconfigureEn]=1 .

D0F0xE4_x0130_8062 Soft Reset Control 0

Cold reset: 0001_0880h.

Bits	Description
31:12	Reserved.
11	ConfigXferMode . Read-write. 1=PCIe core strap settings take effect immediately. 0=PCIe core strap settings take effect when the PCIe core is reset.

10	BlockOnIdle. Read-write. 1=The PCIe core must be idle before hardware initiates a reconfiguration. 0=The PCIe core does not have to be idle before hardware initiates a reconfiguration.
9:5	Reserved.
4:2	ResetPeriod. Read-write. BIOS:2h. Specifies the amount of time that resets are asserted during a reconfiguration. 5h-7h: Reserved.
1	Reserved.
0	ReconfigureEn. Read-write. 1=Atomic reconfiguration enabled.

D0F0xE4_x0130_80F0 BIOS Timer

Reset: 0000_0000h.

Bits	Description
31:0	MicroSeconds. Read-write; Updated-by-hardware. This field increments once every microsecond when the timer is enabled. The counter rolls over and continues counting when it reaches its FFFF_FFFFh. A write to this register causes the counter to reset and begin counting from the value written.

D0F0xE4_x0130_80F1 BIOS Timer Control

Reset: 0000_0064h.

Bits	Description						
31:8	Reserved.						
7:0	ClockRate. Read-write. Specifies the frequency of the reference clock in 1 MHz increments. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Timer disabled</td></tr> <tr> <td>FFh-01h</td><td><ClockRate> MHz</td></tr> </table>	Bits	Definition	00h	Timer disabled	FFh-01h	<ClockRate> MHz
Bits	Definition						
00h	Timer disabled						
FFh-01h	<ClockRate> MHz						

3.3.4 IO Link Registers

D0F0xE4_x0140_0002 IO Link Hardware Debug

Reset: 0000_0000h.

Bits	Description
31:1	Reserved.
0	HwDebug[0]: ignore DLLPs in L1. Read-write. BIOS: 1. 1=DLLPs are ignored in L1 so the TXCLK can be turned off.

D0F0xE4_x0140_0010 IO Link Control 1

Reset: 80E3_110Bh.

Bits	Description
31:13	Reserved.

12:10	RxUmiAdjPayloadSize. Read-write. BIOS: 100b. Payload size for the UMI link.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00xb	Reserved.	100b	64 bytes
	010b	16 bytes	101b	Reserved.
	011b	32 bytes.	11xb	Reserved.
9	UmiNpMemWrite: memory write mapping enable. Read-write. 1=Internal non-posted memory writes are transferred to UMI.			
8:4	Reserved.			
3:1	LcHotPlugDelSel: enhanced hot plug counter select. Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	15 ms	4h	150 ms
	1h	20 ms	5h	200 ms
	2h	50 ms	6h	275 ms
	3h	100 ms	7h	335 ms
0	HwInitWrLock: hardware init write lock. Read-write. 1=Lock HWInit registers. 0=Unlock HWInit registers.			

D0F0xE4_x0140_0011 IO Link Config Control

Reset: 0000_000Fh.

Bits	Description
31:4	Reserved.
3:0	DynClkLatency: dynamic clock latency. Read-write. BIOS: See 2.11.4.3.1 [Link Configuration and Core Initialization] . Specifies the number of clock cycles after logic goes idle before clocks are gated off.

D0F0xE4_x0140_001C IO Link Control 2

Reset: 0E00_0109h.

Bits	Description
31:11	Reserved.
10:6	TxArbMstLimit: transmitter arbitration master limit. Read-write. BIOS: 4h. Defines together with TxArbSlvLimit a round robin arbitration pattern for downstream accesses. TxArbMstLimit defines the weight for downstream CPU requests and TxArbSlvLimit for the downstream read responses.
5:1	TxArbSlvLimit: transmitter arbitration slave limit. Read-write. BIOS: 4h. See TxArbMstLimit for details
0	TxArbRoundRobinEn: transmitter round robin arbitration enabled. Read-write. BIOS: 1. 1=Enable transmitter round robin arbitration. 0=Disable transmitter round robin arbitration.

D0F0xE4_x0140_0020 IO Link Chip Interface Control

Reset: 0000_0050h.

Bits	Description
31:10	Reserved.
9	CiRcOrderingDis: chip interface RC ordering disable. Read-write. 0=RC ordering logic is enabled. 1=RC ordering logic is disabled.
8:0	Reserved.

D0F0xE4_x0140_0040 IO Link Phy Control

Reset: 0001_0000h.

Bits	Description										
31:16	Reserved.										
15:14	PElecIdleMode: electrical idle mode for physical layer. Read-write. BIOS: 11b. Defines which electrical idle signal is used, either inferred by link controller or from phy. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY.</td></tr> <tr> <td>01b</td><td>Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY.</td></tr> <tr> <td>10b</td><td>Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY.</td></tr> <tr> <td>11b</td><td>Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY.</td></tr> </table>	Bits	Definition	00b	Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY.	01b	Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY.	10b	Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY.	11b	Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY.
Bits	Definition										
00b	Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY.										
01b	Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY.										
10b	Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY.										
11b	Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY.										
13:0	Reserved.										

D0F0xE4_x0140_00B0 IO Link Strap Control

Reset: 0000_8001h.

Bits	Description
31:6	Reserved.
5	StrapF0AerEn. Read-write. 1=AER support enabled. 0=AER support disabled.
4:3	Reserved.
2	StrapF0MsiEn. Read-write. BIOS: 1. Overrides MSI enable.
1:0	Reserved.

D0F0xE4_x0140_00C0 IO Link Strap Miscellaneous

Bits	Description
31	Reserved.
30	StrapFlrEn. Read-write.
29	StrapMstAdr64En. Read-write.
28	StrapReverseAll. Read-write. Reset: 0.
27:0	Reserved.

D0F0xE4_x0140_00C1 IO Link Strap Miscellaneous2

Bits	Description
31:2	Reserved.
1	StrapGen2Compliance . Read-write. Reset: 1.
0	StrapLinkBwNotificationCapEn . Read-write. Reset: 0.

D0F0xF8 Northbridge IOAPIC Index

Reset: 0000_0000h. The index/data pair registers, [D0F0xF8](#) and [D0F0xFC](#), are used to access the registers at [D0F0xFC_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0xF8](#), and then the data is read from or written to the data register, [D0F0xFC](#).

Bits	Description
31:8	Reserved.
7:0	IOAPICIndAddr: IOAPIC index register address . Read-write.

D0F0xFC Northbridge IOAPIC Data

Reset: 0000_0000h. See [D0F0xF8](#). Address: [D0F0xF8](#)[IOAPICIndAddr].

Bits	Description
31:0	IOAPICIndData: IOAPIC index data register . Read-write.

D0F0xFC_x00 IOAPIC Feature Control Register

Reset: 0000_0004h.

Bits	Description
31:5	Reserved.
4	IoapicSbFeatureEn . Read-write. 1=Enable masked interrupts to be routed back to the FCH PIC/IOAPIC.
3	Reserved.
2	IoapicIdExtEn . Read-write. Extend the IOAPIC ID from 4-bit to 8-bit. 0=4-bit ID. 1=8-bit ID.
1	Reserved.
0	IoapicEnable . Read-write. 1=Enables the INTGEN block to decode IOAPIC addresses. BIOS: 1. BIOS should always set this bit after programming the IOAPIC BAR in the init sequence.

D0F0xFC_x01 IOAPIC Base Address Lower

Reset: FEC0_0000h. See 3.16 [Northbridge IOAPIC Registers].

Bits	Description
31:8	IoapicAddr. Read-write. IOAPIC Base Address bits [31:8].
7:0	Reserved.

D0F0xFC_x02 IOAPIC Base Address Upper

Reset: 0000_0000h. See 3.16 [Northbridge IOAPIC Registers].

Bits	Description
31:0	IoapicAddrUpper. Read-write. IOAPIC Base Address bits [63:32].

D0F0xFC_x0F IOAPIC GBIF Interrupt Routing Register

Reset: 0000_0000h.

Bits	Description										
31:6	Reserved.										
5:4	GBIFExtIntrSwz. Read-write. Swizzle GBIF INTA/B/C/D based on the value in this field before mapping them onto the IOAPIC pins. <table> <tr> <th>Bits</th><th>Interrupt Swizzling</th></tr> <tr> <td>00b</td><td>ABCD</td></tr> <tr> <td>01b</td><td>BCDA</td></tr> <tr> <td>10b</td><td>CDAB</td></tr> <tr> <td>11b</td><td>DABC</td></tr> </table>	Bits	Interrupt Swizzling	00b	ABCD	01b	BCDA	10b	CDAB	11b	DABC
Bits	Interrupt Swizzling										
00b	ABCD										
01b	BCDA										
10b	CDAB										
11b	DABC										
3	Reserved.										
2:0	GBIFExtIntrGrp. Read-write. Map GBIF INTA/B/C/D to IOAPIC pins [((grp+1)*4)-1:(grp*4)]. For GBIF, only INTA/B are used. INTC/D should be tied off.										

D0F0xFC_x1[4:0] IOAPIC BR Interrupt Routing Register

Reset: 0000_0000h.

Bits	Description
31:21	Reserved.
20:16	BrIntIntrMap. Read-write. Map bridge n interrupts to IOAPIC redirection table entry.
15:6	Reserved.

5:4	BrExtIntrSwz. Read-write. Swizzle bridge n external INTA/B/C/D based on the value in this field before mapping them onto the IOAPIC pins. <table> <tr> <td><u>Bits</u></td><td><u>Interrupt Swizzling</u></td></tr> <tr> <td>00b</td><td>ABCD</td></tr> <tr> <td>01b</td><td>BCDA</td></tr> <tr> <td>10b</td><td>CDAB</td></tr> <tr> <td>11b</td><td>DABC</td></tr> </table>	<u>Bits</u>	<u>Interrupt Swizzling</u>	00b	ABCD	01b	BCDA	10b	CDAB	11b	DABC
<u>Bits</u>	<u>Interrupt Swizzling</u>										
00b	ABCD										
01b	BCDA										
10b	CDAB										
11b	DABC										
3	Reserved.										
2:0	BrExtIntrGrp. Read-write. Map bridge n external INTA/B/C/D to IOAPIC pins $(((grp+1)*4)-1:(grp*4))$.										

D0F0xFC_x30 IOAPIC SPG Interrupt Routing Register

Reset: 0000_0000h.

Bits	Description
31:6	Reserved.
5:4	SpgExtIntrSwz. Read-write. Swizzle SPG INTA/B/C/D before mapping to IOAPIC pins. 0h=ABCD; 1h=BCDA; 2h=CDAB; 3h=DABC.
3	Reserved.
2:0	SpgExtIntrGrp. Read-write. Map SPG INTA/B/C/D to IOAPIC pins $(((grp+1)*4)-1 : (grp*4))$.

D0F0xFC_x31 IOAPIC Serial IRQ Status

Reset: 0000_0000h.

Bits	Description
31:0	InternalIrqSts. Read-only. Shows the status of the 32 IOAPIC interrupt pins.

D0F0xFC_x3[F:E] IOAPIC Scratch [1:0] Register

Reset: 0000_0000h.

Bits	Description
31:0	Scratch. Read-write.

3.4 Device 0 Function 2 (IOMMU) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space]. See 2.12.1 [IOMMU Configuration Space].

D0F2x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1567h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D0F2x04 Status/Command

Bits	Description
31	ParityErrorDetected. Read; write-1-to-clear. Reset: 0.
30	SignaledSystemError. Read-only. Reset: 0.
29	ReceivedMasterAbort. Read; write-1-to-clear. Reset: 0.
28	ReceivedTargetAbort. Read; write-1-to-clear. Reset: 0.
27	SignalTargetAbort. Read-only. Reset: 0.
26:25	Reserved.
24	MasterDataError. Read; write-1-to-clear. Reset: 0.
23:21	Reserved.
20	CapList. Read-only. Reset: 1. 1=Capability list supported.
19	IntStatus. Read-only. Reset: 0. 1=INTx message pending.
18:11	Reserved.
10	InterruptDis. Read-write. Reset: 0. 1=INTx interrupt message generation disabled.
9	Reserved.
8	SerrEn. Read-only. Reset: 0. 1=Enables reporting of non-fatal and fatal errors detected.
7	Reserved.
6	ParityErrorEn. Read-write. Reset: 0. 1=Enables setting of ParityErrorDetected status bit.
5:3	Reserved.
2	BusMasterEn. Read-write. Reset: 0. 1=Enables DMA request generation.
1	MemAccessEn. Read-only. Reset: 0.
0	IoAccessEn. Read-only. Reset: 0.

D0F2x08 Class Code/Revision ID

Reset: 0806_00xxh.

Bits	Description
31:8	ClassCode: class code. Read-only. Provides the IOMMU class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only.

D0F2x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:24	BIST. Read-only.
23:16	HeaderTypeReg. Read-only. 80h=Type 0 multi-function device.
15:8	LatencyTimer. Read-write.
7:0	CacheLineSize. Read-only.

D0F2x2C Subsystem and Subvendor ID

Bits	Description
31:16	SubsystemId. Value: 1567h.
15:0	SubsystemVendorId. Value: 1022h .

D0F2x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapPtr. Read-only. Reset: 40h.

D0F2x3C Interrupt Line

Bits	Description
31:16	Reserved.

15:8	InterruptPin. Read-only. Reset: 01h. This field indicates the INTx line used to generate legacy interrupts. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved.</td></tr> <tr> <td>01h</td><td>INTA.</td></tr> <tr> <td>02h</td><td>INTB.</td></tr> <tr> <td>03h</td><td>INTC.</td></tr> <tr> <td>04h</td><td>INTD.</td></tr> <tr> <td>FFh-05h</td><td>Reserved.</td></tr> </table>	Bits	Description	00h	Reserved.	01h	INTA.	02h	INTB.	03h	INTC.	04h	INTD.	FFh-05h	Reserved.
Bits	Description														
00h	Reserved.														
01h	INTA.														
02h	INTB.														
03h	INTC.														
04h	INTD.														
FFh-05h	Reserved.														
7:0	InterruptLine. Read-write. Reset: 0. This field is read/write for software compatibility. It controls no hardware.														

D0F2x40 IOMMU Capability

Bits	Description
31:29	Reserved.
28	IommuCapExt. Read-only. Reset: 1. Indicate IOMMU capability is extended to include D0F2x54 [IOMMU Miscellaneous Information Register High] . See D0F2x7C[CapExtW] .
27	IommuEfrSup. Read-only. Reset: 1. 1=Indicates IOMMUx30 [Extended Feature Low] is supported. 0= IOMMUx30 is reserved.
26	IommuNpCache. Read-only. Reset: 0. 1=Indicates that the IOMMU caches page table entries that are marked as not present. When this bit is set, software must issue an invalidate after any change to a PDE or PTE. 0=Indicates that the IOMMU caches only page table entries that are marked as present. When this bit is clear, software must issue an invalidate after any change to a PDE or PTE marked present before the change.
25	IommuHtTunnelSup. Read-only. Reset: 0.
24	IommuIoTlbsup. Read-only. Reset: 1. Indicates support for remote IOTLBs. .
23:19	IommuCapRev. Read-only. Reset: 1. Specifies the IOMMU interface revision.
18:16	IommuCapType. Read-only. Reset: 3h. Specifies the layout of the Capability Block as an IOMMU capability block.
15:8	IommuCapPtr. Read-only. Reset: 64h. Indicates the location of the next capability block.
7:0	IommuCapId. Read-only. Reset: Fh. Indicates a Secure Device capability block.

D0F2x44 IOMMU Base Address Low

Bits	Description
31:14	IommuBaseAddr[31:14]: IOMMU base address bits[31:14]. IF (D0F2x44[IommuEnable]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. IommuBaseAddr[63:14] = { D0F2x48[IommuBaseAddr[63:32]] , IommuBaseAddr[31:14]}. IommuBaseAddr[63:14] specifies the base address of the IOMMU memory mapped control registers. In order to use the IOMMU event counters, IommuBaseAddr[18:14] must be 0_0000b.

13:1	Reserved.
0	IommuEnable . Read; write-1-only. Reset: 0. 1=IOMMU accepts memory accesses to the address specified in IommuBaseAddr[63:14]. When this bit is set, all IOMMU RW capability registers in PCI configuration space are locked.

D0F2x48 IOMMU Base Address High

Bits	Description
31:0	IommuBaseAddr[63:32]: IOMMU base address bits[63:32] . See: D0F2x44 [IommuBase-Addr[31:14]].

D0F2x4C IOMMU Range

Bits	Description
31:24	IommuLastDevice . Read-only. Reset: 0. Indicates device and function number of the last integrated device associated with the IOMMU.
23:16	IommuFirstDevice . Read-only. Reset: 0. Indicates device and function number of the first integrated device associated with the IOMMU.
15:8	IommuBusNumber . Read-only. Reset: 0. Indicates the bus number that IommuLastDevice and IommuFirstDevice reside on.
7	IommuRngValid . Read-only. Reset: 0. 1=The IommuBusNumber, IommuFirstDevice, and IommuLastDevice fields are valid. Although the register contents are valid, software is encouraged to use I/O topology information. 0=Software must use I/O topology information.
6:5	Reserved.
4:0	IommuUnitId . Read-only. Reset: 0.

D0F2x50 IOMMU Miscellaneous Information Register

Bits	Description
31:27	IommuMsiNumPpr . Read-only. Reset: 0. This field must indicate which MSI vector is used for the interrupt message generated by the IOMMU for the peripheral page service request log when IOMMUx30 [PprSup]=1. This field must be 0 when IOMMUx30 [PprSup]=0. For MSI there can be only one IOMMU so this field must be 0. This interrupt is not remapped by the IOMMU.
26:23	Reserved.
22	IommuHtAtsResv . IF (D0F2x44 [IommuEnable]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=The link Address Translation address range for ATS responses is reserved and cannot be translated by the IOMMU. 0=The Address Translation address range can be translated by the IOMMU.

21:15	<p>IommuVaSize. Read-only. Reset: 40h. This field must indicate the size of the maximum virtual address processed by the IOMMU. The value is the (unsigned) binary log of the maximum address size.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>19h-00h</td><td>Reserved.</td></tr> <tr> <td>20h</td><td>32 bits.</td></tr> <tr> <td>27h-21h</td><td>Reserved.</td></tr> <tr> <td>28h</td><td>40 bits.</td></tr> <tr> <td>2Fh-29h</td><td>Reserved.</td></tr> <tr> <td>30h</td><td>48 bits.</td></tr> <tr> <td>3Fh-31h</td><td>Reserved.</td></tr> <tr> <td>40h</td><td>64 bits.</td></tr> <tr> <td>7Fh-41h</td><td>Reserved.</td></tr> </table>	Bits	Description	19h-00h	Reserved.	20h	32 bits.	27h-21h	Reserved.	28h	40 bits.	2Fh-29h	Reserved.	30h	48 bits.	3Fh-31h	Reserved.	40h	64 bits.	7Fh-41h	Reserved.
Bits	Description																				
19h-00h	Reserved.																				
20h	32 bits.																				
27h-21h	Reserved.																				
28h	40 bits.																				
2Fh-29h	Reserved.																				
30h	48 bits.																				
3Fh-31h	Reserved.																				
40h	64 bits.																				
7Fh-41h	Reserved.																				
14:8	<p>IommuPaSize. Read-only. Reset: 30h. This field must indicate the size of the maximum physical address generated by the IOMMU. The value is the (unsigned) binary log of the maximum address size.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>27h-00h</td><td>Reserved.</td></tr> <tr> <td>28h</td><td>40 bits.</td></tr> <tr> <td>7Fh-29h</td><td>Reserved.</td></tr> <tr> <td>29h</td><td>Reserved.</td></tr> <tr> <td>30h</td><td>48 bits.</td></tr> <tr> <td>7Fh-31h</td><td>Reserved.</td></tr> </table>	Bits	Description	27h-00h	Reserved.	28h	40 bits.	7Fh-29h	Reserved.	29h	Reserved.	30h	48 bits.	7Fh-31h	Reserved.						
Bits	Description																				
27h-00h	Reserved.																				
28h	40 bits.																				
7Fh-29h	Reserved.																				
29h	Reserved.																				
30h	48 bits.																				
7Fh-31h	Reserved.																				
7:5	<p>IommuGvaSize. Read-only. Reset: 010b. Indicates the size of the maximum guest virtual address processed by the IOMMU.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>001b-000b</td><td>Reserved.</td></tr> <tr> <td>010b</td><td>48 bits.</td></tr> <tr> <td>111b-011b</td><td>Reserved.</td></tr> </table>	Bits	Description	001b-000b	Reserved.	010b	48 bits.	111b-011b	Reserved.												
Bits	Description																				
001b-000b	Reserved.																				
010b	48 bits.																				
111b-011b	Reserved.																				
4:0	<p>IommuMsiNum. Read-only. Reset: 0. Indicates the MSI vector used for interrupt messages generated by the IOMMU.</p>																				

D0F2x54 IOMMU Miscellaneous Information Register High

Bits	Description
31:5	Reserved.
4:0	IommuMsiNumGa. Read-only. Reset: 0. Indicates the MSI vector used for guest AVIC interrupts generated by the IOMMU. This field must be 0 when IOMMUx30[GaSup] =0. This interrupt is not remapped by the IOMMU.

D0F2x64 IOMMU MSI Capability Register

Bits	Description
31:24	Reserved.
23	Msi64En. Read-only. Reset: 1. 1=64-bit MSI addressing is supported

22:20	MsiMultMessEn. Read-write. Reset: 0. Specifies the number of MSI messages assigned to this function.
19:17	MsiMultMessCap. Read-only. Reset: 0. Specifies the number of MSI messages requested by this function.
16	MsiEn. Read-write. Reset: 0. 1=Enables MSI for this function and causes legacy interrupts to be disabled.
15:8	MsiCapPtr. Read-only. Reset: 74h. Pointer to the next capability register offset.
7:0	MsiCapId. Read-only. Reset: 5h. Indicates that this is the MSI capability.

D0F2x68 IOMMU MSI Address Low

Bits	Description
31:2	MsiAddr[31:2]. Read-write. Reset: 0. This register specifies the lower address bits used to issue MSI messages.
1:0	Reserved.

D0F2x6C IOMMU MSI Address High

Bits	Description
31:0	MsiAddr[63:32]. Read-write. Reset: 0. This register specifies the upper address bits used to issue MSI messages.

D0F2x70 IOMMU MSI Data

Bits	Description
31:16	Reserved.
15:0	MsiData. Read-write. Reset: 0. This register specifies the data issued with MSI messages.

D0F2x74 IOMMU MSI Mapping Capability

Bits	Description
31:27	MsiMapCapType. Read-only. Reset: 15h. Indicates the MSI Mapping Capability.
26:18	Reserved.
17	MsiMapFixd. Read-only. Reset: 1. 1=MSI interrupt mapping range is not programmable.
16	MsiMapEn. Read-only. Reset: 1. Always set to 1 to indicate that the MSI Mapping Capability is always enabled
15:8	MsiMapCapPtr. Read-only. Reset: 0. Points to the next capability list item
7:0	MsiMapCapId. Read-only. Reset: 8h. Indicates a link capability list item

D0F2x7C IOMMU Control

Bits	Description
31:14	Reserved.
13	CapExtW. Read-write. Reset: 1. This field sets the value of D0F2x40 [IommuCapExt].
12:10	MsiMultMessCapW. Read-write. Reset: 2h.
9	EfrSupW. Read-write. Reset: 1. This field sets the value of D0F2x40 [IommuEfrSup].
8	IoTlbspW. Read-write. Reset: 1. This field sets the value of D0F2x40 [IommuIoTlbsp].
7:4	MinorRevIdW. Read-write. Reset: 0. This field sets the value of D0F2x08 [RevID[3:0]].
3	Reserved.
2:0	InterruptPinW. Read-write. Reset: 1. This field sets the value of D0F2x3C [InterruptPin].

D0F2x80 IOMMU MMIO Control Low

Bits	Description
31:24	Reserved.
23:21	GamSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [GamSup].
20:12	Reserved.
11:10	HatsW. Read-write. Reset: 2h. This field sets the value of IOMMUx30 [HATS].
9	PcSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [PcSup].
8	Reserved.
7	GaSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [GaSup].
6	IaSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [IaSup].
5	Reserved.
4	GtSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [GtSup].
3	NxSupW. Read-write. Reset: 0. This field sets the value of IOMMUx30 [NxSup]. BIOS: Program D0F2xFC_x07_L1i [4:0][ForceNoExePerm]=1 when NxSupW==0b.
2	Reserved.
1	PprSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [PprSup].
0	PrefSupW. Read-write. Reset: 1. This field sets the value of IOMMUx30 [PrefSup].

D0F2x84 IOMMU MMIO Control High

Bits	Description
31:4	Reserved.
3:0	PasMaxW. Read-write. Reset: 8h. This field sets the value of IOMMUx34 [PasMax].

D0F2x88 IOMMU Range Control

The fields in this register set the values of the corresponding fields in [D0F2x4C](#).

Bits	Description
31:24	LastDeviceW. Read-write. Reset: 0.
23:16	FirstDeviceW. Read-write. Reset: 0.
15:8	BusNumberW. Read-write. Reset: 0.
7	RngValidW. Read-write. Reset: 0.
6:0	Reserved.

D0F2xF0 IOMMU L2 Config Index

The index/data pair registers, [D0F2xF0](#) and [D0F2xF4](#) are used to access the registers at [D0F2xF4_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F2xF0](#), and then the data is read from or written to the data register, [D0F2xF4](#). See [2.12.1 \[IOMMU Configuration Space\]](#).

Bits	Description
31:9	Reserved.
8	L2cfgWrEn. Read-write. Reset: 0.
7:0	L2cfgIndex. Read-write. Reset: 0.

D0F2xF4 IOMMU L2 Config Data

IF ([D0F2xF0](#)[L2cfgWrEn]) THEN Read-write. ELSE Read-only. Reset: 0000_0000h. See [D0F2xF0](#). Address: [D0F2xF0](#)[L2cfgIndex].

Bits	Description
31:0	L2cfgData.

D0F2xF4_x00 L2_PERF_CNTL_0

Bits	Description
31:24	L2PerfCountUpper1. Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 1
23:16	L2PerfCountUpper0. Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 0
15:8	L2PerfEvent1. Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 1.
7:0	L2PerfEvent0. Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 0.

D0F2xF4_x01 L2_PERF_COUNT_0

Bits	Description
31:0	L2PerfCount0. Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 0.

D0F2xF4_x02 L2_PERF_COUNT_1

Bits	Description
31:0	L2PerfCount1 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 1.

D0F2xF4_x03 L2_PERF_CNTL_1

Bits	Description
31:24	L2PerfCountUpper3 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 3.
23:16	L2PerfCountUpper2 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 2.
15:8	L2PerfEvent3 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 3.
7:0	L2PerfEvent2 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 2.

D0F2xF4_x04 L2_PERF_COUNT_2

Bits	Description
31:0	L2PerfCount2 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 2.

D0F2xF4_x05 L2_PERF_COUNT_3

Bits	Description
31:0	L2PerfCount3 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 3.

D0F2xF4_x08 L2_STATUS_0

Bits	Description
31:0	L2STATUS0 . Read-only. Reset: 0. Internal IOMMU L2A status.

D0F2xF4_x0C L2_CONTROL_0

Bits	Description
31:24	IFifoClientPriority . Read-write. Reset: 0. Each bit of this register controls whether the corresponding L1 client is arbitrated as high priority or not. Not all implementations will use all of the priority bits due to a lower number of clients versus the register width.
23:20	IFifoBurstLength . Read-write. Reset: 1. Sets the burst length when arbitrating between clients coming into the L2.
19	Reserved.

18	FLTCMBPriority. Read-write. Reset: 0. 0=Round-robin arbitration between cache responses and table-walker responses at the fault combiner. 1=Table-walker responses always win arbitration at the fault combiner.
17:12	IFifoCMBCredits. Read-write. Reset: 4h. Controls the initial number of credits for the ififo to fault/CMB interface. Credits are loaded whenever the register value changes. This register may only be programmed when IOMMU is not enabled to preserve correct operation.
11	SIDEPTEOnAddrTransExcl. Read-write. Reset: 0. 0=Caches return DTE to L1 on an address translation exclusion range access. 1=Caches return PTE to L1 on an address translation exclusion range access.
10	SIDEPTEOnUntransExcl. Read-write. Reset: 0. 0=Caches return DTE to L1 on an untranslated exclusion range access. 1=Caches return PTE to L1 on an untranslated exclusion range access.
9:4	IFifoTWCredits. Read-write. Reset: 4h. Controls the initial number of credits for the ififo to TW interface. Credits are loaded whenever the register changes value. This register may only be programmed when IOMMU is not enabled to preserve correct operation.
3	DTCHitVZeroOrIVZero. Read-write. Reset: 0. 0=A DTE is refetched if a DTE with V=0 for a memory request or IV=1 for an interrupt request is hit in the DTC. 1=A DTE is not refetched if a DTE with V=0 for a memory request or IV=1 for an interrupt request is hit in the DTC. This DTE is used.
2	AllowL1CacheATSRsp. Read-write. Reset: 0. 0=L2 does not allow L1 to cache responses to ATS address translation requests. 1=L2 allows L1 to cache responses to ATS address translation requests.
1	AllowL1CacheVZero. Read-write. Reset: 0. 0=L2 does not allow L1 to cache DTEs where V=0. 1=L2 allows L1 to cache DTEs where V=1. L1 stores IR and IW as if they are both set to 1.
0	PTCAddrTransReqCheck. Read-write. Reset: 0. 0=Address translation requests do not check the PTC. 1=Address translation requests check the PTC.

D0F2xF4_x0D L2_CONTROL_1

Bits	Description
31:24	PerfThreshold. Read-write. Reset: 0. Fifo threshold level used to calculate certain performance counter values.
23:17	Reserved.
16	SeqInvBurstLimitEn. Read-write. Reset: 1. Enable stalling L2 requests to allow invalidation cycles to make forward progress based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req.
15:8	SeqInvBurstLimitL2Req. Read-write. Reset: 8h. Sets the number of consecutive IOMMU L2 requests to perform when doing sequential invalidation. Regular L2 and invalidation requests will alternate access to the main L2 caches based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req.
7:0	SeqInvBurstLimitInv. Read-write. Reset: 8h. Sets the number of consecutive invalidation requests to perform when doing sequential invalidation. Regular L2 and invalidation requests will alternate access to the main L2 caches based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req.

D0F2xF4_x10 L2_DTC_CONTROL

Bits	Description
31:28	DTCEntries . Read-only. Reset: 0. The number of entries in the DTC is indicated as $2^{\text{DTCEntries}}$.
27:24	Reserved.
23:16	DTCWays . Read-only. Reset: 0. Indicates the number of ways in the DTC.
15	DTCParitySupport . Read-only. Reset: 0. 0=The DTC does not support parity protection . 1=The DTC supports parity protection.
14	Reserved.
13	DTCBypass . Read-write. Reset: 0. When set, all requests bypass the DTC.
12:11	Reserved.
10	DTCSoftInvalidate . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the DTC.
9:8	DTCInvalidationSel . Read-write. Reset: 0. BIOS: 10b. Selects the DTC invalidation algorithm.
Bits	Description
00b	Invalidate the entire DTC.
01b	Fast imprecise invalidation.
10b	Sequential precise invalidation.
11b	Partial sequential precise invalidation.
7:5	Reserved.
4	DTCParityEn . Read-write. Reset: 0. Enable parity protection of the DTC.
3	DTCLRUUpdatePri . Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same DTC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same DTC index.
2	Reserved.
1:0	DTCReplacementSel . Read-write. Reset: 1. Selects the DTC replacement algorithm. Implementation may not support all replacement algorithms.

D0F2xF4_x11 L2_DTC_HASH_CONTROL

Bits	Description
31:16	DtcAddressMask . Read-write. Reset: 0h. This field is a bit-wise AND mask that selects which bits from the untranslated interrupt {MT[2:0],Vector} are used to index into the DTC.
15:11	Reserved.
10	DtcAltHashEn . Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the DTC.
9	Reserved.
8:5	DTCBusBits . Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the DTC address. The following equation must be satisfied. $\text{Func_bits} + \text{Dev_Bits} + \text{Bus_Bits} \leq \log_2(\text{DTC entries} / \text{DTC associativity})$.

4:2	DTCDevBits . Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the DTC address.
1:0	DTCFuncBits . Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the DTC address.

D0F2xF4_x12 L2_DTC_WAY_CONTROL

Bits	Description
31:16	DTCWayAccessDisable . Read-write. Reset: 0.
15:0	DTCWayDisable . Read-write. Reset: 0. Each bit in this register disables a way in the DTC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the DTCWays lower bits of this register.

D0F2xF4_x14 L2_ITC_CONTROL

Bits	Description										
31:28	ITCEntries . Read-only. Reset: 0. The number of entries in the ITC is indicated as $2^{\text{ITCEntries}}$.										
27:24	Reserved.										
23:16	ITCWays . Read-only. Reset: 0. Indicates the number of ways in the ITC.										
15	ITCParitySupport . Read-only. Reset: 0. 0=The ITC does not support parity protection . 1=The ITC supports parity protection.										
14	Reserved.										
13	ITCBypass . Read-write. Reset: 0. When set, all requests bypass the ITC.										
12:11	Reserved.										
10	ITCSoftInvalidate . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the ITC.										
9:8	ITCInvalidationSel . Read-write. Reset: 0. BIOS: See 2.12.2. Selects the ITC invalidation algorithm. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Invalidate the entire ITC.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation</td></tr> </table>	Bits	Description	00b	Invalidate the entire ITC.	01b	Fast imprecise invalidation.	10b	Sequential precise invalidation.	11b	Partial sequential precise invalidation
Bits	Description										
00b	Invalidate the entire ITC.										
01b	Fast imprecise invalidation.										
10b	Sequential precise invalidation.										
11b	Partial sequential precise invalidation										
7:5	Reserved.										
4	ITCParityEn . Read-write. Reset: 0. Enable parity protection of the ITC.										
3	ITCLRUUpdatePri . Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same ITC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same ITC index.										
2	Reserved.										
1:0	ITCReplacementSel . Read-write. Reset: 1. Selects the ITC replacement algorithm. Implementation may not support all replacement algorithms.										

D0F2xF4_x15 L2_ITC_HASH_CONTROL

Bits	Description
31:16	ITCAddressMask. Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which bits from the untranslated interrupt {MT[2:0],Vector} are used to index into the ITC.
15:11	Reserved.
10	IteAltHashEn. Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the ITC.
9	Reserved.
8:5	ITCBusBits. Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the ITC address. The following equation must be satisfied. $\text{Func_bits} + \text{Dev_Bits} + \text{Bus_Bits} \leq \log_2(\text{ITC entries} / \text{ITC associativity})$.
4:2	ITCDevBits. Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the ITC address.
1:0	ITCFuncBits. Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the ITC address.

D0F2xF4_x16 L2_ITC_WAY_CONTROL

Bits	Description
31:16	ITCWayAccessDisable. Read-write. Reset: 0.
15:0	ITCWayDisable. Read-write. Reset: 0. Each bit in this register disables a way in the ITC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the ITCWays lower bits of this register.

D0F2xF4_x18 L2_PTC_A_CONTROL

Bits	Description
31:28	PTCAEntries. Read-only. Reset: 0. The number of entries in the PTC A sub-cache is indicated as $2^{\text{PTCAEntries}}$
27:24	Reserved.
23:16	PTCAWays. Read-only. Reset: 0. Indicates the number of ways in the PTC A sub-cache
15	PTCAParitySupport. Read-only. Reset: 0. 0=The PTC A sub-cache does not support parity protection . 1=The PTC A sub-cache supports parity protection
14	Reserved.
13	PTCABypass. Read-write. Reset: 0. When set, all requests bypass the PTC A sub-cache.
12	Reserved.
11	PTCA2MMode. Read-write. Reset: 0. When set, the PTC A sub-cache stores 2M pages instead of 4K pages
10	PTCASoftInvalidate. Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PTC A sub-cache

9:8	PTCAInvalidationSel. Read-write. Reset: 0. BIOS: See 2.12.2. Selects the PTC A sub-cache invalidation algorithm. <div> <div>Bits</div> <div>Description</div> </div> <div> <div>00b</div> <div>Invalidate the entire PTC A sub-cache.</div> </div> <div> <div>01b</div> <div>Fast imprecise invalidation.</div> </div> <div> <div>10b</div> <div>Sequential precise invalidation.</div> </div> <div> <div>11b</div> <div>Partial sequential precise invalidation.</div> </div>
7:5	Reserved.
4	PTCAParityEn. Read-write. Reset: 0. Enable parity protection of the PTC A sub-cache
3	PTCALRUUpdatePri. Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PTCA index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same PTCA index
2	Reserved.
1:0	PTCAReplacementSel. Read-write. Reset: 1. Selects the PTC A sub-cache replacement algorithm. Implementation may not support all replacement algorithms

D0F2xF4_x19 L2_PTC_A_HASH_CONTROL

Bits	Description
31:16	PTCAAddressMask. Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PTC A sub-cache.
15:11	Reserved.
10	PtcAltHashEn. Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the PTC.
9	Reserved.
8:5	PTCABusBits. Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the PTC A sub-cache address. The following equation must be satisfied. $\text{FuncBits} + \text{DevBits} + \text{BusBits} \leq \log_2(\text{PTC A sub-cache entries} / \text{PTC A sub-cache associativity})$.
4:2	PTCDevBits. Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the PTC A sub-cache address.
1:0	PTCAFuncBits. Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the PTC A sub-cache address.

D0F2xF4_x1A L2_PTC_A_WAY_CONTROL

Bits	Description
31:16	PTCAWayAccessDisable. Read-write. Reset: 0.
15:0	PTCAWayDisable. Read-write. Reset: 0. Each bit in this register disables a way in the PTC A sub-cache when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PTCAWays lower bits of this register.

D0F2xF4_x1C L2_PTC_B_CONTROL

Bits	Description										
31:28	PTCBEntries . Read-only. Reset: 0. The number of entries in the PTC B sub-cache is indicated as $2^{\text{PTCBEntries}}$.										
27:24	Reserved.										
23:16	PTCBWays . Read-only. Reset: 0. Indicates the number of ways in the PTC B sub-cache.										
15	PTCBParitySupport . Read-only. Reset: 0. 0=The PTC B sub-cache does not support parity protection . 1=The PTC B sub-cache supports parity protection.										
14	Reserved.										
13	PTCBBypass . Read-write. Reset: 0. When set, all requests bypass the PTC B sub-cache.										
12	Reserved.										
11	PTCB2MMode . Read-write. Reset: 0. When set, the PTC B sub-cache stores 2M pages instead of 4K pages.										
10	PTCBSoftInvalidate . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PTC B sub-cache.										
9:8	PTCBInvalidationSel . Read-write. Reset: 0. Selects the PTC B sub-cache invalidation algorithm. <table border="1"> <thead> <tr> <th>Bits</th><th>Description</th></tr> </thead> <tbody> <tr> <td>00b</td><td>Invalidate the entire PTC B sub-cache.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation.</td></tr> </tbody> </table>	Bits	Description	00b	Invalidate the entire PTC B sub-cache.	01b	Fast imprecise invalidation.	10b	Sequential precise invalidation.	11b	Partial sequential precise invalidation.
Bits	Description										
00b	Invalidate the entire PTC B sub-cache.										
01b	Fast imprecise invalidation.										
10b	Sequential precise invalidation.										
11b	Partial sequential precise invalidation.										
7:5	Reserved.										
4	PTCBParityEn . Read-write. Reset: 0. Enable parity protection of the PTC B sub-cache.										
3	PTCBLRUUpdatePri . Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PTCB index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same PTCB index.										
2	Reserved.										
1:0	PTCBReplacementSel . Read-write. Reset: 1. Selects the PTC B sub-cache replacement algorithm. Implementation may not support all replacement algorithms.										

D0F2xF4_x1D L2_PTC_B_HASH_CONTROL

Bits	Description
31:16	PTCBAddressMask . Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PTC B sub-cache.
15:9	Reserved.
8:5	PTCBBusBits . Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the PTC B sub-cache address. The following equation must be satisfied. $\text{FuncBits} + \text{DevBits} + \text{Bus-Bits} \leq \log_2(\text{PTC B sub-cache entries} / \text{PTC B sub-cache associativity})$.

4:2	PTCBDevBits. Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the PTC B sub-cache address.
1:0	PTCBFuncBits. Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the PTC B sub-cache address.

D0F2xF4_x1E L2_PTC_B_WAY_CONTROL

Bits	Description
31:16	PTCBWayAccessDisable. Read-write. Reset: 0.
15:0	PTCBWayDisable. Read-write. Reset: 0. Each bit in this register disables a way in the PTC A sub-cache when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PTCBWays lower bits of this register.

D0F2xF4_x20 L2_CREDIT_CONTROL_2

Bits	Description
31:28	Reserved.
27:24	PprLoggerCredits. Read-write. Reset: 4h. PPR log buffer credit override value.
23	FCELOverride. Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FCEL credit counter with FCELCredits. This should only be performed when the IOMMU is idle.
22	Reserved.
21:16	FCELCredits. Read-write. Reset: 0. FCEL credit override value.
15	FLTCMBOverride. Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FLTCMB credit counter with FLTCMBCredits. This should only be performed when the IOMMU is idle.
14	Reserved.
13:8	FLTCMBCredits. Read-write. Reset: 0. FLTCMB credit override value.
7	QUEUEOverride. Read-write. Reset: 0. Changing this register from 0 to 1 overrides the QUEUE credit counter with QUEUECredits. This should only be performed when the IOMMU is idle.
6	Reserved.
5:0	QUEUECredits. Read-write. Reset: 0. QUEUE credit override value.

D0F2xF4_x22 L2A_UPDATE_FILTER_CNTL

Bits	Description
31:5	Reserved.
4:1	L2aUpdateFilterRdlatency. Read-write. Reset: 3h. When L2a_Update_Filter_Bypass is 0, assume the invalidation read has completed in the number of clock cycles specified by this field.
0	L2aUpdateFilterBypass. Read-write. Reset: 1. 1=Disable duplicate update filtering. 0=Enable the dropping of updates that are already in the L2aUpdateFilter or in the destination L2a cache.

D0F2xF4_x30 L2_ERR_RULE_CONTROL_3

Bits	Description
31:4	ERRRuleDisable3 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.
3:1	Reserved.
0	ERRRuleLock1 . Read-write. Reset: 0. BIOS: See 2.12.2. This register is write-once. Setting this register bit locks the error detection rule set in ERRRuleDisable3 , D0F2xF4_x31 [ERRRuleDisable4] and D0F2xF4_x32 [ERRRuleDisable5].

D0F2xF4_x31 L2_ERR_RULE_CONTROL_4

Bits	Description
31:0	ERRRuleDisable4 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.

D0F2xF4_x32 L2_ERR_RULE_CONTROL_5

Bits	Description
31:0	ERRRuleDisable5 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.

D0F2xF4_x33 L2_L2A_CK_GATE_CONTROL

Bits	Description										
31:8	Reserved.										
7:6	CKGateL2AStop . Read-write. Reset: 01b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>01b</td><td>Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>10b</td><td>Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>11b</td><td>Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> </table>	Bits	Description	00b	Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.	01b	Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.	10b	Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.	11b	Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.
Bits	Description										
00b	Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.										
01b	Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.										
10b	Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.										
11b	Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.										
5:4	CKGateL2ALength . Read-write. Reset: 01b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 128 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>01b</td><td>Allow 256 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>10b</td><td>Allow 512 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>11b</td><td>Allow 1024 clock cycles delay before stopping the clocks when idle asserts.</td></tr> </table>	Bits	Description	00b	Allow 128 clock cycles delay before stopping the clocks when idle asserts.	01b	Allow 256 clock cycles delay before stopping the clocks when idle asserts.	10b	Allow 512 clock cycles delay before stopping the clocks when idle asserts.	11b	Allow 1024 clock cycles delay before stopping the clocks when idle asserts.
Bits	Description										
00b	Allow 128 clock cycles delay before stopping the clocks when idle asserts.										
01b	Allow 256 clock cycles delay before stopping the clocks when idle asserts.										
10b	Allow 512 clock cycles delay before stopping the clocks when idle asserts.										
11b	Allow 1024 clock cycles delay before stopping the clocks when idle asserts.										
3	CKGateL2ASpare . Read-write. Reset: 0. Spare bit.										
2	CKGateL2ACacheDisable . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b upper cache ways.										

1	CKGateL2ADynamicDisable. Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b dynamic clock branch.
0	CKGateL2ARegsDisable. Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b register clock branch.

D0F2xF4_x34 L2_L2A_PGFSIZE_CONTROL

Bits	Description
31:4	Reserved.
3:2	L2aregHostPgsz. Read-write. Reset: 0. BIOS: See 2.12.2 .
1:0	L2aregGstPgsz. Read-write. Reset: 0. BIOS: See 2.12.2 .

D0F2xF4_x3B IOMMU_PGFSM_CONFIG

Bits	Description
31:28	RegAddr. Read-write. Reset: 0. Indicate the register address for write or read operation.
27	SrbmOverride. Read-write. Reset: 0.
26:14	Reserved.
13	PGRead. Read-write. Reset: 0. Indicate a read operation is performed.
12	PGWrite. Read-write. Reset: 0. Indicate a write operation is performed.
11	Reserved.
10	P1Select. Read-write. Reset: 0. Indicate the power up or down is for P1 domain.
9	PowerUp. Read-write. Reset: 0. Request power up.
8	PowerDown. Read-write. Reset: 0. Request power down.
7:0	FsmAddr. Read-write. Reset: 0. Indicate the address of the PGFSM. 0xFFh = broadcast to all PGFSM.

D0F2xF4_x3C IOMMU_PGFSM_WRITE

Bits	Description
31:0	WriteValue. Read-write. Reset: 0.

D0F2xF4_x3D IOMMU_PGFSM_READ

Bits	Description
31:24	Reserved.
23:0	ReadValue. Read-only. Reset: 0.

D0F2xF4_x40 L2_PERF_CNTL_2

Bits	Description
31:24	L2PerfCountUpper5 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 5
23:16	L2PerfCountUpper4 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 4
15:8	L2PerfEvent5 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 5
7:0	L2PerfEvent4 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 4

D0F2xF4_x41 L2_PERF_COUNT_4

Bits	Description
31:0	L2PerfCount4 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 4

D0F2xF4_x42 L2_PERF_COUNT_5

Bits	Description
31:0	L2PerfCount5 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 5

D0F2xF4_x43 L2_PERF_CNTL_3

Bits	Description
31:24	L2PerfCountUpper7 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 7
23:16	L2PerfCountUpper6 . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 6
15:8	L2PerfEvent7 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 7
7:0	L2PerfEvent6 . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 6

D0F2xF4_x44 L2_PERF_COUNT_6

Bits	Description
31:0	L2PerfCount6 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 6

D0F2xF4_x45 L2_PERF_COUNT_7

Bits	Description
31:0	L2PerfCount7 . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 7

D0F2xF4_x48 L2_STATUS_1

Bits	Description
31:0	L2STATUS1 . Read-only. Reset: 0. Internal IOMMU L2B status

D0F2xF4_x49 L2_SB_LOCATION

Bits	Description												
31:16	SbLocatedCore . Read-write. Reset: 0. Specifies the core location of the FCH. <table> <tr> <th>Bit</th><th>PortLocation</th></tr> <tr> <td>[0]</td><td>FCH is located under PPD</td></tr> <tr> <td>[1]</td><td>FCH is located under SBG</td></tr> <tr> <td>[15:2]</td><td>Reserved.</td></tr> </table>	Bit	PortLocation	[0]	FCH is located under PPD	[1]	FCH is located under SBG	[15:2]	Reserved.				
Bit	PortLocation												
[0]	FCH is located under PPD												
[1]	FCH is located under SBG												
[15:2]	Reserved.												
15:0	SbLocatedPort . Read-write. Reset: 0. BIOS: See 2.12.2 [IOMMU Initialization] . Specifies the port location of the FCH. <table> <tr> <th>Bit</th><th>PortLocation</th></tr> <tr> <td>[0]</td><td>FCH is located on port A of the corresponding PCIe core or internal FCH</td></tr> <tr> <td>[1]</td><td>FCH is located on port B of the corresponding PCIe core</td></tr> <tr> <td>[2]</td><td>FCH is located on port C of the corresponding PCIe core</td></tr> <tr> <td>[3]</td><td>FCH is located on port D of the corresponding PCIe core</td></tr> <tr> <td>[15:4]</td><td>Reserved.</td></tr> </table>	Bit	PortLocation	[0]	FCH is located on port A of the corresponding PCIe core or internal FCH	[1]	FCH is located on port B of the corresponding PCIe core	[2]	FCH is located on port C of the corresponding PCIe core	[3]	FCH is located on port D of the corresponding PCIe core	[15:4]	Reserved.
Bit	PortLocation												
[0]	FCH is located on port A of the corresponding PCIe core or internal FCH												
[1]	FCH is located on port B of the corresponding PCIe core												
[2]	FCH is located on port C of the corresponding PCIe core												
[3]	FCH is located on port D of the corresponding PCIe core												
[15:4]	Reserved.												

D0F2xF4_x4C L2_CONTROL_5

Bits	Description
31:12	Reserved.
11:10	Reserved.
9:8	GstPartialPtcCntl . Read-write. Reset: 0. BIOS: 11b.
7	FC2AltMode . Read-write. Reset: 0. 0=FC2 primary flow-control mode. 1=FC2 alternate flow-control mode.
6	FC3Dis . Read-write. Reset: 0. 0=FC3 flow-control loop is enabled. 1=FC3 flow-control loop is disabled.
5	FC2Dis . Read-write. Reset: 0. 0=FC2 flow-control loop is enabled. 1=FC2 flow-control loop is disabled.
4	DTCUpdateVZeroIVOne . Read-write. Reset: 0. 0=DTEs with V=0 and IV=1 are not cached in the DTC. 1=DTEs with V=0 and IV=1 are cached in the DTC.
3	DTCUpdateVOneIVZero . Read-write. Reset: 0. 0=DTEs with V=1 and IV=0 are not cached in the DTC. 1=DTEs with V=1 and IV=0 are cached in the DTC.
2	FC1Dis . Read-write. Reset: 0. 0=FC1 flow control loop enabled. 1=FC1 flow control loop disabled.

1	PTCAddrTransReqUpdate. Read-write. Reset: 1. 0=PTEs from address translation requests are not cached. 1=PTEs from address translation requests are cached in the L2 according to the Cache bit in the DTE.
0	QueueArbFBPri. Read-write. Reset: 1. 0=Requests in the miss queue and the feedback queue are arbitrated in a round-robin manner. 1=Requests in the feedback queue are given priority over requests in the miss queue.

D0F2xF4_x4D L2_CONTROL_6

Bits	Description
31:24	Perf2Threshold. Read-write. Reset: 0. Fifo threshold level used to calculate certain performance counter values.
23:17	Reserved.
16	SeqInvBurstLimitEn. Read-write. Reset: 1. Enable stalling PDC requests to allow invalidation cycles to make forward progress based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq.
15:8	SeqInvBurstLimitPDCReq. Read-write. Reset: 8h. Sets the number of consecutive IOMMU PDC requests to perform when doing sequential invalidation. PDC and invalidation requests will alternate access to the PDC based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq.
7:0	SeqInvBurstLimitInv. Read-write. Reset: 8h. Sets the number of consecutive invalidation requests to perform when doing sequential invalidation. PDC and invalidation requests will alternate access to the PDC based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq.

D0F2xF4_x50 L2_PDC_CONTROL

Bits	Description
31:28	PDCEntries. Read-only. Reset: 0. Indicates the number of entries in the PDC is indicated as $2^{\text{PDCEntries}}$
27:24	Reserved.
23:16	PDCWays. Read-only. Reset: 0. Indicates the number of ways in the PDC
15	PDCParitySupport. Read-only. Reset: 0. 0=The PDC does not support parity protection . 1=The PDC supports parity protection
14	Reserved.
13	PDCBypass. Read-write. Reset: 0. When set, all requests bypass the PDC. This prevents the multiple issue of requests and increases maximum rate of requests to the table-walker.
12	PDCSearchDirection. Read-write. Reset: 0. 0=Search PDC from higher levels down . 1=Search PDC from lower levels up
11	Reserved.
10	PDCSoftInvalidate. Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PDC

9:8	PDCInvalidationSel. Read-write. Reset: 0. BIOS: See 2.12.2. Selects the PDC invalidation algorithm. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Invalidate the entire PDC.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation</td></tr> </table>	Bits	Description	00b	Invalidate the entire PDC.	01b	Fast imprecise invalidation.	10b	Sequential precise invalidation.	11b	Partial sequential precise invalidation
Bits	Description										
00b	Invalidate the entire PDC.										
01b	Fast imprecise invalidation.										
10b	Sequential precise invalidation.										
11b	Partial sequential precise invalidation										
7:5	Reserved.										
4	PDCParityEn. Read-write. Reset: 0. Enable parity protection of the PDC if the device supports parity										
3	PDCLRUUpdatePri. Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PDC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same PDC index										
2	Reserved.										
1:0	PDCReplacementSel. Read-write. Reset: 1. Selects the PDC replacement algorithm. Implementation may not support all replacement algorithms										

D0F2xF4_x51 L2_PDC_HASH_CONTROL

Bits	Description
31:16	PDCAddressMask. Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PDC.
15:11	Reserved.
10	PdcAltHashEn. Read-write. Reset: 0. 1=Enable alternative algorithm for generating hash index into the PDC.
9	PDCUpperLvlAddrHash. Read-write. Reset: 1. When set to 1, the PDC cache index is partially formed using the xor of the LSBs of virtual address bits for all levels greater than or equal to the stored/searched level.
8	PDCLvlHash. Read-write. Reset: 1. When set to 1, the PDE level is used as part of the hash for the cache index.
7:6	Reserved.
5:0	PDCDomainBits. Read-write. Reset: 7h. Selects the number of domain bits to use as part of the index into the PDC

D0F2xF4_x52 L2_PDC_WAY_CONTROL

Bits	Description
31:16	PDCWayAccessDisable. Read-write. Reset: 0.
15:0	PDCWayDisable. Read-write. Reset: 0. Each bit in this register disables a way in the PDC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PDCWays lower bits of this register.

D0F2xF4_x53 L2B_UPDATE_FILTER_CNTL

Bits	Description
31:5	Reserved.
4:1	L2bUpdateFilterRdlatency . Read-write. Reset: 3h. When L2bUpdateFilterBypass is 0, assume the invalidation read has completed in the number of clock cycles specified by this field.
0	L2bUpdateFilterBypass . Read-write. Reset: 1. 1=Disable duplicate update filtering. 0 =Enable the dropping of updates that are already in the l2b_update_filter or in the PDC.

D0F2xF4_x54 L2_TW_CONTROL

Bits	Description
31:19	Reserved.
18	TwContWalkPErrDis . Read-write. Reset: 0. 0=Continue walking tables on a write permission error. 1=Stop walking tables on a write permission error
17	Twfilter64bDis . Read-write. Reset: 0.
16	TwfilterDis . Read-write. Reset: 0.
15	Reserved.
14:12	TWPrefetchRange . Read-write. Reset: 1. Selects the number of pages to prefetch
11	TWPTEOnAddrTransExcl . Read-write. Reset: 0. 0=Table walker returns DTE to L1 on an address translation exclusion range access . 1=Table walker returns PTE to L1 on an address translation exclusion range access
10	TWPTEOnUntransExcl . Read-write. Reset: 0. 0=Table walker returns DTE to L1 on an untranslated exclusion range access . 1=Table walker returns PTE to L1 on an untranslated exclusion range access
9	TWPrefetchOnly4KDis . Read-write. Reset: 0. 1=Allow non-4K pages to be prefetched . 0=Only 4K pages are prefetched
8	TWPrefetchEn . Read-write. Reset: 0. Enable prefetching in the table-walker
7	Reserved.
6	TWForceCoherent . Read-write. Reset: 0. 1=Table-walker always genereates coherent requests. The DTE SD bit is ignored when this bit is set to 1.
5:0	TWQueueLimit . Read-write. Reset: 10h. Limit the number of outstanding table-walker requests

D0F2xF4_x56 L2_CP_CONTROL

Bits	Description
31:16	CPRdDelay . Read-write. Reset: 0. Command processor read delay
15:3	Reserved.
2	CPFlushOnInv . Read-write. Reset: 1. BIOS: 0. 1=Command processor flushes out old requests on every invalidation command. 0=No flush is performed during invalidations.

1	CPFlushOnWait . Read-write. Reset: 0. BIOS: 1. 1=Command processor flushes out old requests on completion wait. 0=No flush is performed on completion wait.
0	CPPrefetchDis . Read-write. Reset: 0. 1=Command processor fetches and executes only one command at a time. 0=Command processor prefetches available commands into its internal storage.

D0F2xF4_x57 L2_CP_CONTROL_1

Bits	Description
31:16	Reserved.
15:3	CPL1Off[15:3] . Read-write. Reset: 0. Each bit in this register indicates to the IOMMU command processor that a corresponding L1 TLB is inaccessible due to static clock or power gating. System software is responsible for programming this register.
2	L1ImuIntGfxDis . Read-write. Reset: 0. BIOS: IF (GpuEnabled) THEN 0 ELSE 1 ENDIF.
1	CPL1Off[1] . Read-write. Reset: 0.
0	L1ImuPcieGfxDis . Read-write. Reset: 0. BIOS: This bit should be set if there is no external graphics in the system.

D0F2xF4_x58 IOMMU_L2_GUEST_ADDR_CNTRL

Bits	Description
31:24	Reserved.
23:0	IommuL2GuestAddrMask . Read-write. Reset: 0.

D0F2xF4_x6A L2_INT_CONTROL

Bits	Description
31:4	Reserved.
3	IntGaOrderEn . Read-write. Reset: 1. 1=Enable ordering between interrupts and guest APIC log writes.
2	IntPPROrderEn . Read-write. Reset: 1. 1=Enable ordering between interrupts and ppr log writes.
1	IntCPOrderEn . Read-write. Reset: 1. 1=Enable ordering between interrupts and command processor writes.
0	IntEventOrderEn . Read-write. Reset: 1. 1=Enable ordering between interrupts and event log writes.

D0F2xF4_x70 L2_CREDIT_CONTROL_0

Bits	Description
31	DTEOverride . Read-write. Reset: 0. 1=Override the DTE credit counter with DTECredits. Setting should only be performed when the IOMMU is idle.
30	Reserved.
29:24	DTECredits . Read-write. Reset: 2h. DTE credit override value.

23	FC3Override. Read-write. Reset: 0. 1=Override the FC3 credit counter with FC3Credits. Setting should only be performed when the IOMMU is idle.
22	Reserved.
21:16	FC3Credits. Read-write. Reset: 0. FC3 credit override value.
15	FC2Override. Read-write. Reset: 0. 1=Override the FC2 credit counter with FC2Credits. This should only be performed when the IOMMU is idle.
14	Reserved.
13:8	FC2Credits. Read-write. Reset: 0. FC2 credit override value.
7	FC1Override. Read-write. Reset: 0. 1=Override the FC1 credit counter with FC1Credits. Setting should only be performed when the IOMMU is idle.
6	Reserved.
5:0	FC1Credits. Read-write. Reset: 0. FC1 credit override value.

D0F2xF4_x71 L2_CREDIT_CONTROL_1

Bits	Description
31:24	Reserved.
23:20	PprMcifCredits. Read-write. Reset: 4h. PPR logger credit override value.
19:16	CpPrefetchCredits. Read-write. Reset: 4h. Command processor prefetch credit override value.
15	TWELOverride. Read-write. Reset: 0. 1=Override the TWEL credit counter with TWELCredits. Setting should only be performed when the IOMMU is idle.
14	Reserved.
13:8	TWELCredits. Read-write. Reset: 4h. TWEL credit override value.
7	PDTIEOverride. Read-write. Reset: 0. 1=Override the PDTIE credit counter with PDTIECredits. Setting should only be performed when the IOMMU is idle.
6	Reserved.
5:0	PDTIECredits. Read-write. Reset: 4h. PDTIE credit override value.

D0F2xF4_x78 L2_MCIF_CONTROL

Bits	Description
31:29	Reserved.
28:24	MCIFBaseWriteDataCredits. Read-write. Reset: 8h. Sets the number of base-channel write data credits between the IOMMU L2 and the HTIU/ORB. Software must ensure no traffic is on this data path while programming this register.
23:21	Reserved.
20:16	MCIFBaseWriteHdrCredits. Read-write. Reset: 8h. Sets the number of base-channel write header credits between the IOMMU L2 and the HTIU/ORB. Software must ensure no traffic is on this data path while programming this register.
15:13	Reserved.

12:8	MCIFIsocReadCredits . Read-write. Reset: 8h. Sets the number of isoc-channel read credits between the IOMMU L2 and the HTIU/ORB. Software must ensure no traffic is on this data path while programming this register.
7:5	Reserved.
4:0	MCIFBaseReadCredits . Read-write. Reset: 8h. Sets the number of base-channel read credits between the IOMMU L2 and the HTIU/ORB. Software must ensure no traffic is on this data path while programming this register.

D0F2xF4_x80 L2_ERR_RULE_CONTROL_0

Bits	Description
31:4	ERRRuleDisable0 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.
3:1	Reserved.
0	ERRRuleLock0 . Read-write. Reset: 0. BIOS: See 2.12.2. This register is write-once. Setting this register bit locks the error detection rule set in ERRRuleDisable0/1/2 .

D0F2xF4_x81 L2_ERR_RULE_CONTROL_1

Bits	Description
31:0	ERRRuleDisable1 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.

D0F2xF4_x82 L2_ERR_RULE_CONTROL_2

Bits	Description
31:0	ERRRuleDisable2 . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.

D0F2xF4_x90 L2_L2B_CK_GATE_CONTROL

Bits	Description										
31:8	Reserved.										
7:6	CKGateL2BStop . Read-write. Reset: 01b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>01b</td><td>Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>10b</td><td>Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>11b</td><td>Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> </table>	Bits	Description	00b	Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.	01b	Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.	10b	Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.	11b	Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.
Bits	Description										
00b	Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.										
01b	Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.										
10b	Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.										
11b	Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.										

5:4	CKGateL2BLength . Read-write. Reset: 01b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 128 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>01b</td><td>Allow 256 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>10b</td><td>Allow 512 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>11b</td><td>Allow 1024 clock cycles delay before stopping the clocks when idle asserts.</td></tr> </table>	Bits	Description	00b	Allow 128 clock cycles delay before stopping the clocks when idle asserts.	01b	Allow 256 clock cycles delay before stopping the clocks when idle asserts.	10b	Allow 512 clock cycles delay before stopping the clocks when idle asserts.	11b	Allow 1024 clock cycles delay before stopping the clocks when idle asserts.
Bits	Description										
00b	Allow 128 clock cycles delay before stopping the clocks when idle asserts.										
01b	Allow 256 clock cycles delay before stopping the clocks when idle asserts.										
10b	Allow 512 clock cycles delay before stopping the clocks when idle asserts.										
11b	Allow 1024 clock cycles delay before stopping the clocks when idle asserts.										
3	CKGateL2BCacheDisable . Read-write. Reset: 0. 1=Disable the gating of the l2b upper cache ways.										
2	CKGateL2BMiscDisable . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b miscellaneous clock branch.										
1	CKGateL2BDynamicDisable . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b dynamic clock branch.										
0	CKGateL2BRegsDisable . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b register clock branch.										

D0F2xF4_x92 PPR_CONTROL

Bits	Description
31:17	Reserved.
16	PprIntcoalesceEn . Read-write. Reset: 0. BIOS: See 2.12.2 .
15:8	PprIntreqdelay . Read-write. Reset: 0. BIOS: See 2.12.2 .
7:0	PprInttimedelay . Read-write. Reset: 0. BIOS: See 2.12.2 .

D0F2xF4_x94 L2_L2B_PGFSIZE_CONTROL

Bits	Description
31:4	Reserved.
3:2	L2bregHostPgsz . Read-write. Reset: 0. BIOS: See 2.12.2 .
1:0	L2bregGstPgsz . Read-write. Reset: 0. BIOS: See 2.12.2 .

D0F2xF8 IOMMU L1 Config Index

The index/data pair registers, [D0F2xF8](#) and [D0F2xFC](#) are used to access the registers at [D0F2xFC_x\[FFFF:0000\]_L1\[3:0\]](#). To access any of these registers, the address is first written into the index register, [D0F2xF8](#), and then the data is read from or written to the data register, [D0F2xFC](#).

See [2.12.1 \[IOMMU Configuration Space\]](#). There are various L1s in the IOMMU. Registers in the L1 indexed space have one instance per L1 denoted by [_L1i\[x\]](#) where $x = \text{D0F2xF8}[\text{L1cfgSel}]$. The syntax for this register type is described by the following example:

- [D0F2xFC_x00](#) refers to all instances of the [D0F2xFC_x00](#) registers.
- [D0F2xFC_x00_L1i\[0\]](#) refers to the [D0F2xFC_x00](#) register instance for the PPD L1.

Bits	Description
31	L1cfgEn . Read-write. Reset: 0. 1=Enable writes to D0F2xFC .
30:20	Reserved.

19:16	L1cfgSel. Read-write. Reset: 0. This field selects one of the following L1s to access.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	PPD	3h	INTGEN
	1h	SBG	4h	PSP
	2h	BIF	Fh-5h	Reserved
15:0	L1cfgIndex. Read-write. Reset: 0.			

D0F2xFC IOMMU L1 Config Data

IF ([D0F2xF8](#)[L1cfgEn]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0000_0000h. See [D0F2xF8](#). Address: [D0F2xF8](#)[L1cfgIndex].

Bits	Description
31:0	L1cfgData.

D0F2xFC_x00_L1i[4:0] L1_PERF_CNTL

Bits	Description
31:24	L1PerfCountHi1. Read-only. Reset: 0. read back of perf counter 1 bits 39:32.
23:16	L1PerfCountHi0. Read-only. Reset: 0. read back of perf counter 0 bits 39:32.
15:8	L1PerfEvent1. Read-write. Reset: 0. perf counter event 1.
7:0	L1PerfEvent0. Read-write. Reset: 0. perf counter event 0.

D0F2xFC_x01_L1i[4:0] L1_PERF_COUNT_0

Bits	Description
31:0	L1PerfCount0. Read-only. Reset: 0. read back of perf counter 0 bits 31:0.

D0F2xFC_x02_L1i[4:0] L1_PERF_COUNT_1

Bits	Description
31:0	L1PerfCount1. Read-only. Reset: 0. read back of perf counter 1 bits 31:0.

D0F2xFC_x07_L1i[4:0] L1_DEBUG_1

Bits	Description
31:18	Reserved.
17	L1NwEn. Read-write. Reset: 0. BIOS: 1. 1=Enable NW bit on ATS requests.
16:15	Reserved.
14	AtsPhysPageOverlapDis. Read-write. Reset: 0. BIOS: 1. 1=Prevent physical page overlap for ATS responses.
13	Reserved.

12	AtsSeqNumEn. Read-write. Reset: 0. BIOS: 1. 1=Enable logging of ATS sequence number.
11	SpecReqFilterEn. Read-write. Reset: 0. BIOS: 1. 1=Filter special requests in L1 work queue.
10:1	Reserved.
0	PhantomFuncDis. Read-write. Reset: 0. BIOS: See 2.12.2 . 1=Disable phantom function support.

D0F2xFC_x09_L1i[4:0] L1_SB_LOCATION

Bits	Description												
31:16	SbLocatedCore. Read-only. Reset: 0.												
15:0	<p>SbLocatedPort. Read-write. Reset: 0. BIOS: See 2.12.2 [IOMMU Initialization]. Specifies the port location of the FCH.</p> <table> <tr> <th>Bit</th><th>PortLocation</th></tr> <tr> <td>[0]</td><td>FCH is located on port A of the corresponding PCIe core or internal FCH</td></tr> <tr> <td>[1]</td><td>FCH is located on port B of the corresponding PCIe core</td></tr> <tr> <td>[2]</td><td>FCH is located on port C of the corresponding PCIe core</td></tr> <tr> <td>[3]</td><td>FCH is located on port D of the corresponding PCIe core</td></tr> <tr> <td>[15:4]</td><td>Reserved.</td></tr> </table>	Bit	PortLocation	[0]	FCH is located on port A of the corresponding PCIe core or internal FCH	[1]	FCH is located on port B of the corresponding PCIe core	[2]	FCH is located on port C of the corresponding PCIe core	[3]	FCH is located on port D of the corresponding PCIe core	[15:4]	Reserved.
Bit	PortLocation												
[0]	FCH is located on port A of the corresponding PCIe core or internal FCH												
[1]	FCH is located on port B of the corresponding PCIe core												
[2]	FCH is located on port C of the corresponding PCIe core												
[3]	FCH is located on port D of the corresponding PCIe core												
[15:4]	Reserved.												

D0F2xFC_x0C_L1i[4:0] L1_CNTRL_0

Bits	Description														
31	Reserved.														
30:28	<p>L1VirtOrderQueues. Read-write. Reset: 0. BIOS: See 2.12.2. This field controls number of virtual queues in the L1 work queue.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>1</td></tr> <tr> <td>1h</td><td>2</td></tr> <tr> <td>2h</td><td>4</td></tr> <tr> <td>3h</td><td>8</td></tr> <tr> <td>4h</td><td>16</td></tr> <tr> <td>7h-5h</td><td>Reserved</td></tr> </table>	Bits	Description	0h	1	1h	2	2h	4	3h	8	4h	16	7h-5h	Reserved
Bits	Description														
0h	1														
1h	2														
2h	4														
3h	8														
4h	16														
7h-5h	Reserved														
27:24	L1Entries. Read-only; updated-by-hardware. Reset: 0. This field specifies the number of entries in each L1 cache as $2^{L1entries}$.														
23:22	Reserved.														
21:20	L1Banks. Read-only; updated-by-hardware. Reset: 1. This field specifies number of caches in L1.														
19:14	Reserved.														
13:8	L2Credits. Read-write. Reset: 4h. This field controls credits for L1 to L2 interface.														
7:6	Reserved.														
5	ReplacementSel. Read-write. Reset: 0.														
4	Reserved.														
3	CacheiwOnly. Read-write. Reset: 1. 1=Cache write only pages in L1.														
2	CacheirOnly. Read-write. Reset: 1. 1=Cache read only pages in L1.														

1	FragmentDis. Read-write. Reset: 0. 1=Disable variable page size support in L1 cache - only 4K pages.
0	UnfilterDis. Read-write. Reset: 0. 1=Disable unfiltering in L1 wq of aborted L2 requests.

D0F2xFC_x0D_L1i[4:0] L1_CNTRL_1

Bits	Description
31:30	Reserved.
29	Untrans2mFilteren. Read-write. Reset: 0. Enable filtering of requests on a 2M boundry instead of 4K.
28	PretransNovaFilteren. Read-write. Reset: 0. When set, VA is not used for filtering pretrans requests.
27	L1CacheSelInterleave. Read-write. Reset: 0. when set causes cache updates to toggle between multiple caches.
26	L1CacheSelReqid. Read-write. Reset: 0. when set will allow the reqid to be used in hashing between multiple L1 caches.
25:23	SelectTimeoutPulse. Read-write. Reset: 0.
22	L1CacheInvAllEn. Read-write. Reset: 0. Enables invalidation of entire cache when invalidation command is sent.
21	L1orderEn. Read-write. Reset: 0. Enables strict ordering of all requests through L1.
20	SndFilterDis. Read-write. Reset: 0. Disables filtering of requests to L2.
19	AtsNobufferInsert. Read-write. Reset: 0. disables buffering of read completion data when inserting ats responses.
18:14	WqEntrydis. Read-write. Reset: 0. Value indicates how many cache entries in L1 to disable.
13	BlockL1Dis. Read-only. Reset: 0.
12	L1DTEDis. Read-write. Reset: 0. Disables L1 caching of DTE.
11	L1ParityEn. Read-write. Reset: 0.
10	L1CacheParityEn. Read-write. Reset: 0. Enables forced miss of L1 cache due to failed parity check.
9	CacheByPass. Read-write. Reset: 0. Enables L1 cache bypass.
8	VOQXorMode. Read-write. Reset: 0.
7	Reserved.
6:4	VOQFuncBits. Read-write. Reset: 0.
3	Reserved.
2:0	VOQPortBits. Read-write. Reset: 0. !000b=Enable virtual queue hashing using port id, controls number of bits to use from port id for hashing.

D0F2xFC_x0E_L1i[4:0] L1_CNTRL_2

Bits	Description
31:28	Reserved.
27:20	MsiHtRsvIntVector. Read-write. Reset: 00h. This field defines the interrupt vector used when an MSI interrupt is received that has a reserved DM field.

19:12	MsiHtRsvIntDestination. Read-write. Reset: FFh. This field defines the interrupt destination used when an MSI interrupt is received that has a reserved DM field.
11	Reserved.
10	MsiHtRsvIntDM. Read-write. Reset: 0. Defines the interrupt destination mode when an MSI interrupt is received that has a reserved DM field.
9	MsiHtRsvIntRqEio. Read-write. Reset: 0. Specifies the RQEOI state when an MSI interrupt is received that has a reserved DM field.
8:6	MsiHtRsvIntMt. Read-write. Reset: 011b. Specifies the message type used when an MSI interrupt is received that has a reserved DM field.
5:3	Reserved.
2	L1AbtAtsDis. Read-write. Reset: 0. 1=Disable abort of ats requests when IOMMU is disabled.
1	MsiToHtRemapDis. Read-write. Reset: 0. 1=Disable mapping of MSI to link interrupts.
0	Reserved.

D0F2xFC_x0F_L1i[4:0] L1_CNTRL_3

Bits	Description
31:0	AtsTlbinvPulseWidth. Read-write. Reset: C350h. Specifies the pulse width of the ats invalidation counters.

D0F2xFC_x10_L1i[4:0] L1_BANK_SEL_0

Bits	Description
31:16	Reserved.
15:0	L1cachebanksel0. Read-write. Reset: 1. Specifies value is used to determine the virtual address bit that selects between the 2 banks of the L1 cache (if present). The bank is selected by bitwise ANDing this register against virtual address bits 19:12 and XORing the result.

D0F2xFC_x11_L1i[4:0] L1_BANK_DISABLE_0

Bits	Description
31:14	Reserved.
13:8	L1cachelinedis1. Read-write. Reset: 0. sets the number of cache entries to disable in cache 1.
7:6	Reserved.
5:0	L1cachelinedis0. Read-write. Reset: 0. sets the number of cache entries to disable in cache 0.

D0F2xFC_x20_L1i[4:0] L1_WQ_STATUS_0**Table 109: Valid Values for D0F2xFC_x20_L1i[4:0]**

Bits	Description
0h	Idle.
1h	Wait_L1.
2h	Wait_L2.
3h	Sending special request to L2.
4h	Waiting for completion of special request.
5h	Done.

Bits	Description
31:30	Reserved.
29:27	EntryStatus9 . See: EntryStatus0.
26:24	EntryStatus8 . See: EntryStatus0.
23:21	EntryStatus7 . See: EntryStatus0.
20:18	EntryStatus6 . See: EntryStatus0.
17:15	EntryStatus5 . See: EntryStatus0.
14:12	EntryStatus4 . See: EntryStatus0.
11:9	EntryStatus3 . See: EntryStatus0.
8:6	EntryStatus2 . See: EntryStatus0.
5:3	EntryStatus1 . See: EntryStatus0.
2:0	EntryStatus0 . Read-only. Reset: 0. See: Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]].

D0F2xFC_x21_L1i[4:0] L1_WQ_STATUS_1

Bits	Description
31:30	Reserved.
29:27	EntryStatus19 . See: EntryStatus10.
26:24	EntryStatus18 . See: EntryStatus10.
23:21	EntryStatus17 . See: EntryStatus10.
20:18	EntryStatus16 . See: EntryStatus10.
17:15	EntryStatus15 . See: EntryStatus10.
14:12	EntryStatus14 . See: EntryStatus10.
11:9	EntryStatus13 . See: EntryStatus10.
8:6	EntryStatus12 . See: EntryStatus10.
5:3	EntryStatus11 . See: EntryStatus10.
2:0	EntryStatus10 . Read-only. Reset: 0. See: Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]].

D0F2xFC_x22_L1i[4:0] L1_WQ_STATUS_2

Bits	Description
31:30	Reserved.
29:27	EntryStatus29 . See: EntryStatus20.
26:24	EntryStatus28 . See: EntryStatus20.
23:21	EntryStatus27 . See: EntryStatus20.
20:18	EntryStatus26 . See: EntryStatus20.
17:15	EntryStatus25 . See: EntryStatus20.
14:12	EntryStatus24 . See: EntryStatus20.
11:9	EntryStatus23 . See: EntryStatus20.
8:6	EntryStatus22 . See: EntryStatus20.
5:3	EntryStatus21 . See: EntryStatus20.
2:0	EntryStatus20 . Read-only. Reset: 0. See: Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]] .

D0F2xFC_x23_L1i[4:0] L1_WQ_STATUS_3

Bits	Description
31:16	Reserved.
15:8	InvalidationStatus . Read-only. Reset: 0. Status of invalidation state machine.
7:6	Reserved.
5:3	EntryStatus31 . See: EntryStatus30.
2:0	EntryStatus30 . Read-only. Reset: 0. See: Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]] .

D0F2xFC_x32_L1i[4:0] L1_CNTRL_4

Bits	Description
31:21	Reserved.
20	TaggedFenceEn . Read-write. Reset: 0. 0 = Tagged fence disable, L1 uses dma target done interface to complete flushes. 1 = L1 uses tagged fence to complete flushes.
19:17	ForceDmaAttrLow . Read-write. Reset: 0.
16	DmaNpHaltDis . Read-write. Reset: 0.
15:10	DmaBufMaxNpCred . Read-write. Reset: Fh.
9:4	DmaBufCredits . Read-write. Reset: 10h.
3	TlpprefixerrEn . Read-write. Reset: 0.
2	TimeoutPulseExtEn . Read-write. Reset: 0.
1	AtsMultipleL1toL2En . Read-write. Reset: 0. BIOS: See 2.12.2 .
0	AtsMultipleRespEn . Read-write. Reset: 0. BIOS: See 2.12.2 .

D0F2xFC_x33_L1i[4:0] L1_CLKCNTRL_0

Bits	Description
31	L1L2ClkgateEn. Read-write. Reset: 0. BIOS: 1.
30:12	Reserved.
11	L1HostreqClkgateEn. Read-write. Reset: 0. BIOS: 1.
10	L1RegClkgateEn. Read-write. Reset: 0. BIOS: 1.
9	L1MemoryClkgateEn. Read-write. Reset: 0. BIOS: 1.
8	L1PerfClkgateEn. Read-write. Reset: 0. BIOS: 1.
7	L1DmaInputClkgateEn. Read-write. Reset: 0. BIOS: 1.
6	L1CpslvClkgateEn. Read-write. Reset: 0. BIOS: 1.
5	L1CacheClkgateEn. Read-write. Reset: 0. BIOS: 1.
4	L1DmaClkgateEn. Read-write. Reset: 0. BIOS: 1.
3:2	Reserved.
1:0	L1ClkgateLen. Read-write. Reset: 0.

D0F2xFC_x34_L1i[4:0] L1_MEMPWRCNTRL_0

Bits	Description
31:24	L1MempwrTimer2. Read-write. Reset: Fh.
23:16	L1MempwrTimer1. Read-write. Reset: Fh.
15:8	L1MempwrTimer0. Read-write. Reset: Fh.
7:1	Reserved.
0	L1MempwrEn. Read-write. Reset: 0.

D0F2xFC_x35_L1i[4:0] L1_MEMPWRCNTRL_1

Bits	Description
31:8	Reserved.
7:0	L1MempwrTimer3. Read-write. Reset: Fh.

D0F2xFC_x36_L1i[4:0] L1_GUEST_ADDR_CNTRL

Bits	Description
31:8	L1GuestAddrMsk. Read-write. Reset: 0.
7:1	Reserved.
0	L1CanonicalErrEn. Read-write. Reset: 0.

D0F2xFC_x37_L1i[4:0] L1_FEATURE_SUP_CNTRL

Bits	Description
31:2	Reserved.
1	L1PprSup . Read-write. Reset: 1.
0	L1EfrSup . Read-write. Reset: 1.

D0F2xFC_x38_L1i[4:0] L1_CNTRL_5

Bits	Description
31:25	Reserved.
24	IocNpHaltEn . Read-write. Reset: 1. 0 = disable non-posted request stalling. 1 = enable non-posted request stalling when IOC asserts np_halt to L1.
23:20	Reserved.
19:16	HostReqCredits . Read-write. Reset: 8h. Number of credits available at initial state for the host request interface from L1 to downstream client.
15	Reserved.
14	VdmArbSizeEn . Read-write. Reset: 0. Support for arbitrary size vendor defined messages.
13:8	ClkOffWaitTime . Read-write. Reset: 00_0011b. Programmable delay between clkready de-assert and lclk_idle assert (ie. turning off clk).
7:6	Reserved.
5:4	HstCredits . Read-write. Reset: 10b. Number of credits available for host response credit/debit interface.
3:0	DmaCredits . Read-write. Reset: 8h. Number of credits available for dma request credit/debit interface.

D0F2xFC_x39_L1i[4:0] L1_PGMEM_CNTRL1

Bits	Description
31:3	Reserved.
2	SDEn: Shut Down Enable . Read-write. Reset: 0. 0 = disable power gated memories in L1 enters shut down state. 1 = enable power gated memories in L1 enters shut down state.
1	DSEn: Deep Sleep Enable . Read-write. Reset: 0. 0 = disable power gated memories in L1 enters deep sleep state. 1 = enable power gated memories in L1 enters deep sleep state.
0	LSEn: Light Sleep Enable . Read-write. Reset: 0. 0 = disable power gated memories in L1 enters light sleep state. 1 = enable power gated memories in L1 enters light sleep state.

D0F2xFC_x3A_L1i[4:0] L1_PGMEM_CNTRL2

Bits	Description
31:0	LSThres: Light Sleep Threshold. Read-write. Reset: 0. The number of LCLK cycles L1 stays in idle state before entering light sleep when D0F2xFC_x39_L1i[4:0][LSEn] = 1.

D0F2xFC_x3B_L1i[4:0] L1_PGMEM_CNTRL3

Bits	Description
31:0	DSThres: Deep Sleep Threshold. Read-write. Reset: 0. The number of LCLK cycles L1 stays in idle state before switching from previous power state to deep sleep when D0F2xFC_x39_L1i[4:0][DSEn] = 1.

D0F2xFC_x3C_L1i[4:0] L1_PGMEM_CNTRL4

Bits	Description
31:0	SDThres: Shut Down Threshold. Read-write. Reset: 0. The number of LCLK cycles L1 stays in idle state before switching from previous power state to shut down when D0F2xFC_x39_L1i[4:0][SDEn] = 1.

3.5 Device 1 Function 0 (Internal Graphics) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D1F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: Product-specific.
15:0	VendorID: vendor ID. Read-only. Value: 1002h.

D1F0x04 Status/Command Register

Reset: 0010_0000h.

Bits	Description
31	ParityErrorDetected: detected parity error. Read; Write-1-to-clear. 1=Poisoned TLP received.
30	SignaledSystemError: signaled system error. Read; Write-1-to-clear. 1=A non-fatal or fatal error message was sent and SerrEn=1.
29	ReceivedMasterAbort: received master abort. Read; Write-1-to-clear. 1=A completion with an unsupported request completion status was received.
28	ReceivedTargetAbort: received target abort. Read; Write-1-to-clear. 1=A completion with completer abort completion status was received.
27	SignalTargetAbort: Signaled target abort. Read-only.
26:25	DevselTiming: DEVSEL# Timing. Read-only.
24	MasterDataPerr: master data parity error. Read; Write-1-to-clear. 1=ParityErrorEn=1 and either a poisoned completion was received or the device poisoned a write request.
23	FastBackCapable: fast back-to-back capable. Read-only.
22	UDFEn: UDF enable. Read-only.
21	PCI66En: 66 MHz capable. Read-only.
20	CapList: capability list. Read-only. 1=Capability list supported.
19	IntStatus: interrupt status. Read-only. 1=INTx interrupt message pending.
18:11	Reserved.
10	IntDis: interrupt disable. Read-write. 1=INTx interrupt messages generation disabled.
9	FastB2BEn: fast back-to-back enable. Read-only.
8	SerrEn: System error enable. Read-write. 1=Enables reporting of non-fatal and fatal errors detected.
7	Stepping: Stepping control. Read-only.
6	ParityErrorEn: parity error response enable. Read-write.
5	PalSnoopEn: VGA palette snoop enable. Read-only.
4	MemWriteInvalidateEn: memory write and invalidate enable. Read-only.

3	SpecialCycleEn: special cycle enable. Read-only.
2	BusMasterEn: bus master enable. Read-write. 1=Memory and IO read and write request generation enabled.
1	MemAccessEn: IO access enable. Read-write. This bit controls if memory accesses targeting this device are accepted. 1=Enabled. 0=Disabled.
0	IoAccessEn: IO access enable. Read-write. This bit controls if IO accesses targeting this device are accepted. 1=Enabled. 0=Disabled.

D1F0x08 Class Code/Revision ID Register

Bits	Description
31:8	ClassCode. Value: 03_0000h.
7:0	RevID: revision ID. Value: Product-specific.

D1F0x0C Header Type Register

Reset: 0080_0000h.

Bits	Description
31:24	BIST. Read-only.
23:16	HeaderTypeReg. Read-only. The header type field indicates a header type 0 and that this is a multi-function device.
15:8	LatencyTimer. Read-only. These bits are fixed at their default value.
7:0	CacheLineSize. Read-write. This field specifies the system cache line size in units of double words.

D1F0x10 Graphic Memory Base Address

IF (D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1) THEN Reset: 0000_0008h. ELSE Reset: 0000_000Ch. ENDIF.

Bits	Description										
31:26	BaseAddr[31:26]: base address. Read-write. The amount of memory requested by the graphics memory BAR is controlled by D0F0xD4_x0109_1507[StrapBifMemApSizePin] and D0F0xD4_x0109_14E1[StrapBifMemApSize].										
25:4	BaseAddr[25:4]: base address. Read-only.										
3	Pref: prefetchable. Read-only. 1=Prefetchable memory region.										
2:1	Type: base address register type. Read-only. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>32-bit BAR</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>64-bit BAR</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	32-bit BAR	01b	Reserved	10b	64-bit BAR	11b	Reserved
Bits	Description										
00b	32-bit BAR										
01b	Reserved										
10b	64-bit BAR										
11b	Reserved										
0	MemSpace: memory space type. Read-only. 0=Memory mapped base address.										

D1F0x14 Graphics Memory Base Address 64

Reset: 0000_0000h.

Bits	Description
31:0	BaseAddr[63:32]: base address. Read-write. This field is reserved if (D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1).

D1F0x18 Graphics Doorbell Base Address

IF (D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1) THEN Reset: 0000_0008h. ELSE Reset: 0000_000Ch. ENDIF. This register is reserved and reset is 0000_0000h if (D0F0xD4_x0109_14E1[StrapBifDoorbellBarDis]==1).

Bits	Description										
31:23	BaseAddr[31:23]: base address. Read-write.										
22:4	BaseAddr[22:4]: base address. Read-only.										
3	Pref: prefetchable. Read-only. 1=Prefetchable memory region.										
2:1	Type: base address register type. Read-only. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>32-bit BAR</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>64-bit BAR</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	32-bit BAR	01b	Reserved	10b	64-bit BAR	11b	Reserved
Bits	Description										
00b	32-bit BAR										
01b	Reserved										
10b	64-bit BAR										
11b	Reserved										
0	MemSpace: memory space type. Read-only. 0=Memory mapped base address.										

D1F0x1C Graphics Doorbell Base Address 64

Reset: 0000_0000h.

Bits	Description
31:0	BaseAddr[63:32]: base address. Read-write. This field is reserved if (D0F0xD4_x0109_14E1[StrapBifDoorbellBarDis]==1 D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1).

D1F0x20 Graphics IO Base Address

Reset: 0000_0000h. This register is called Base Address 4 if (D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1).

Bits	Description
31:0	Reserved.

D1F0x24 Graphics Memory Mapped Registers Base Address

Reset: 0000_0000h.

Bits	Description
31:16	BaseAddr[31:16]: base address. Read-write. The amount of memory requested by the graphics memory mapped registers BAR is controlled by D0F0xD4_x0109_14E1 [StrapBifRegApSize].
15:4	BaseAddr[15:4]: base address. Read-only.
3	Pref: prefetchable. Read-only. 0=Non-prefetchable memory region.
2:1	Type: base address register type. Read-only. 00b=32-bit BAR.
0	MemSpace: memory space type. Read-only. 0=Memory mapped base address.

D1F0x2C Subsystem and Subvendor ID RegisterReset: 0000_0000h. This register can be modified through [D1F0x4C](#)

Bits	Description
31:16	SubsystemID. Read-only.
15:0	SubsystemVendorID. Read-only.

D1F0x30 Expansion ROM Base Address

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F0x34 Capabilities Pointer

Reset: 0000_0050h.

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Pointer to PM capability.

D1F0x3C Interrupt Line

Reset: 0000_01FFh.

Bits	Description
31:16	Reserved.
15:8	InterruptPin: interrupt pin. Read-only. This field identifies the legacy interrupt message the function uses.
7:0	InterruptLine: interrupt line. Read-write. This field contains the interrupt line routing information.

D1F0x4C Subsystem and Subvendor ID Mirror

Reset: 0000_0000h.

Bits	Description
31:16	SubsystemID . Read-write. This field sets the value in the corresponding field in D1F0x2C .
15:0	SubsystemVendorID . Read-write. This field sets the value in the corresponding field in D1F0x2C .

D1F0x50 Power Management Capability

Bits	Description
31:27	PmeSupport . Value: 0_0000b. Indicates that there is no PME support.
26	D2Support: D2 support . Value: 1. D2 is supported.
25	D1Support: D1 support . Value: 1. D1 is supported.
24:22	AuxCurrent: auxiliary current . Value: 0.
21	DevSpecificInit: device specific initialization . Value: 0. Indicates that there is no device specific initialization necessary.
20	Reserved.
19	PmeClock . Value: 0.
18:16	Version: version . Value: 011b.
15:8	NextPtr: next pointer . Value: 58h
7:0	CapID: capability ID . Value: 01h. Indicates that the capability structure is a PCI power management data structure.

D1F0x54 Power Management Control and Status

Reset: 0000_0000h.

Bits	Description
31:24	PmeData . Read-only.
23	BusPwrEn . Read-only.
22	B2B3Support . Read-only. B states are not supported.
21:16	Reserved.
15	PmeStatus: PME status . Read-only.
14:13	DataScale: data scale . Read-only.
12:9	DataSelect: data select . Read-only.
8	PmeEn: PME# enable . Read-only.
7:4	Reserved.
3	NoSoftReset: no soft reset . Read-only. Software is required to re-initialize the function when returning from D3hot.

2	Reserved.						
1:0	PowerState: power state. Read-write. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>D0</td></tr> <tr> <td>11b</td><td>D3hot</td></tr> </table>	Bits	Definition	00b	D0	11b	D3hot
Bits	Definition						
00b	D0						
11b	D3hot						

D1F0x58 PCI Express® Capability

Bits	Description
31:30	Reserved.
29:25	IntMessageNum: interrupt message number. Value: 0. This field indicates which MSI vector is used for the interrupt message.
24	SlotImplemented: Slot implemented. Value: 0.
23:20	DeviceType: device type. Value: 9h.
19:16	Version. Value: 2h.
15:8	NextPtr: next pointer. Value: Product-specific.
7:0	CapID: capability ID. Value: 10h.

D1F0x5C Device Capability

Bits	Description
31:29	Reserved.
28	FlrCapable: function level reset capability. Value: 0.
27:26	CapturedSlotPowerScale: captured slot power limit scale. Value: 0.
25:18	CapturedSlotPowerLimit: captured slot power limit value. Value: 0.
17:16	Reserved.
15	RoleBasedErrReporting: role-based error reporting. Value: 1.
14:12	Reserved.
11:9	L1AcceptableLatency: endpoint L1 Acceptable Latency. Value: 111b.
8:6	L0SAcceptableLatency: endpoint L0s Acceptable Latency. Value: 110b.
5	ExtendedTag: extended tag support. Value: 1. 8 bit tag support.
4:3	PhantomFunc: phantom function support. Value: 0. No phantom functions supported.
2:0	MaxPayloadSupport: maximum supported payload size. Value: 000b. 128 bytes max payload size.

D1F0x60 Device Control and Status

Reset: 0000_0810h.

Bits	Description
31:22	Reserved.

21	TransactionsPending: transactions pending. Read-only.
20	AuxPwr: auxiliary power. Read-only.
19	UsrDetected: unsupported request detected. Read; Write-1-to-clear. 1=Unsupported request received.
18	FatalErr: fatal error detected. Read; Write-1-to-clear. 1=Fatal error detected.
17	NonFatalErr: non-fatal error detected. Read; Write-1-to-clear. 1=Non-fatal error detected.
16	CorrErr: correctable error detected. Read; Write-1-to-clear. 1=Correctable error detected.
15	BridgeCfgRetryEn: bridge configuration retry enable. Read-only.
14:12	MaxRequestSize: maximum request size. Read-only.
11	NoSnoopEnable: enable no snoop. Read-write. 1=The device is permitted to set the No Snoop bit in requests.
10	AuxPowerPmEn: auxiliary power PM enable. Read-only. This capability is not implemented.
9	PhantomFuncEn: phantom functions enable. Read-only. Phantom functions are not supported.
8	ExtendedTagEn: extended tag enable. Read-write. 1=8-bit tag request tags. 0=5-bit request tag.
7:5	MaxPayloadSize: maximum supported payload size. Read-only. 000b=Indicates a 128 byte maximum payload size.
4	RelaxedOrdEn: relaxed ordering enable. Read-write. 1=The device is permitted to set the Relaxed Ordering bit.
3	UsrReportEn: unsupported request reporting enable. Read-write. 1=Enables signaling unsupported requests by sending error messages.
2	FatalErrEn: fatal error reporting enable. Read-write. 1=Enables sending ERR_FATAL message when a fatal error is detected.
1	NonFatalErrEn: non-fatal error reporting enable. Read-write. 1=Enables sending ERR_NONFATAL message when a non-fatal error is detected.
0	CorrErrEn: correctable error reporting enable. Read-write. 1=Enables sending ERR_CORR message when a correctable error is detected.

D1F0x64 Link Capability

Bits	Description
31:24	PortNumber: port number. Read-only. Value: 0. This field indicates the PCI Express port number for the given PCI Express link.
23	Reserved.
22	AspmOptionalityCompliance: ASP Optionality ECN capability. Read-only. Value: 0b.
21	LinkBWNnotificationCap: link bandwidth notification capability. Read-only. Value: 0b.
20	DLActiveReportingCapable: data link layer active reporting capability. Read-only. Value: 0b.
19	SurpriseDownErrReporting: surprise down error reporting capability. Read-only. Value: 0b.
18	ClockPowerManagement: clock power management. Read-only. Value: 0b.
17:15	L1ExitLatency: L1 exit latency. Read-only. Value: 0b.
14:12	L0sExitLatency: L0s exit latency. Read-only. Value: 0b.
11:10	PMSupport: active state power management support. Read-only. Value: 0b.

9:4	LinkWidth: maximum link width. Read-only. Value: 0.
3:0	LinkSpeed: link speed. Read-only. Value: 0b.

D1F0x68 Link Control and Status

Reset: 0000_0000h.

Bits	Description												
31	LinkAutonomousBWStatus: link autonomous bandwidth status. Read-only.												
30	LinkBWManagementStatus: link bandwidth management status. Read-only.												
29	DLActive: data link layer link active. Read-only. This bit indicates the status of the data link control and management state machine. Reads return a 1 to indicate the DL_Active state, otherwise 0 is returned.												
28	SlotClockCfg: slot clock configuration. Read-only. 1=the root port uses the same clock that the platform provides.												
27	LinkTraining: link training. Read-only. 1=Indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state.												
26	Reserved.												
25:20	NegotiatedLinkWidth: negotiated link width. Read-only. This field indicates the negotiated width of the given PCI Express link.												
19:16	LinkSpeed: link speed. Read-only.												
15:12	Reserved.												
11	LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable. Read-only.												
10	LinkBWManagementEn: link bandwidth management interrupt enable. Read-only.												
9	HWAutonomousWidthDisable: hardware autonomous width disable. Read-only. 1=Hardware not allowed to change the link width except to correct unreliable link operation by reducing link width.												
8	ClockPowerManagementEn: clock power management enable. Read-only.												
7	ExtendedSync: extended sync. Read-only. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.												
6	CommonClockCfg: common clock configuration. Read-only. 1=Indicates that the root port and the component at the opposite end of this Link are operating with a distributed common reference clock. 0=Indicates that the upstream port and the component at the opposite end of this Link are operating with asynchronous reference clock.												
5	RetrainLink: retrain link. Read-only. This bit does not apply to endpoints.												
4	LinkDis: link disable. Read-only. This bit does not apply to endpoints.												
3	ReadCplBoundary: read completion boundary. Read-only. 0=64 byte read completion boundary.												
2	Reserved.												
1:0	PmControl: active state power management enable. Read-only. This field controls the level of ASPM supported on the given PCI Express link. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Disabled.</td><td>10b</td><td>L1 Entry Enabled.</td></tr><tr><td>01b</td><td>L0s Entry Enabled.</td><td>11b</td><td>L0s and L1 Entry Enabled.</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	Disabled.	10b	L1 Entry Enabled.	01b	L0s Entry Enabled.	11b	L0s and L1 Entry Enabled.
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	Disabled.	10b	L1 Entry Enabled.										
01b	L0s Entry Enabled.	11b	L0s and L1 Entry Enabled.										

D1F0x7C Device Capability 2

Reset: 0000_0000h.

Bits	Description												
31:24	Reserved.												
23:22	MaxEndEndTlpPrefixes: Max number of End-End TLP prefixes supported. Read-only. IF (D1F0x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>4 End-End TLP Prefixes.</td><td>10b</td><td>2 End-End TLP Prefixes.</td></tr><tr><td>01b</td><td>1 End-End TLP Prefix.</td><td>11b</td><td>3 End-End TLP Prefixes.</td></tr></table>	Bits	Definition	Bits	Definition	00b	4 End-End TLP Prefixes.	10b	2 End-End TLP Prefixes.	01b	1 End-End TLP Prefix.	11b	3 End-End TLP Prefixes.
Bits	Definition	Bits	Definition										
00b	4 End-End TLP Prefixes.	10b	2 End-End TLP Prefixes.										
01b	1 End-End TLP Prefix.	11b	3 End-End TLP Prefixes.										
21	EndEndTlpPrefixSupported: End-End TLP Prefix supported. Read-only.												
20	ExtendedFmtFieldSupported. Read-only. 1=Function supports 3-bit definition of Fmt field. 0=Function supports 2-bit definition of Fmt field.												
19:18	ObffSupported: Optimized buffer flush/fill supported. Read-only.												
17:14	Reserved.												
13:12	TphCplrSupported. Read-only.												
11	LtrSupported: Latency Tolerance Reporting supported. Read-only.												
10	NoRoEnabledP2pPassing. Read-only.												
9:6	Reserved.												
5	AriForwardingSupported: ARI forwarding supported. Read-only.												
4	CplTimeoutDisSupported: completion timeout disable supported. Read-only.												
3:0	CplTimeoutRangeSupported: completion timeout range supported. Read-only.												

D1F0x80 Device Control and Status 2

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15	EndEndTlpPrefixBlocking. Read-only.
14:13	ObffEn. Read-only.
12:11	Reserved.
10	LtrEn. Read-only.
9	IdoCompletionEn. Read-only.
8	IdoRequestEn. Read-only.
7:6	Reserved.
5	AriForwardingEn. Read-only.
4	CplTimeoutDis: completion timeout disable. Read-only.
3:0	CplTimeoutValue: completion timeout range supported. Read-only.

D1F0x84 Link Capability 2

Bits	Description
31:9	Reserved.
8	CrosslinkSupported: Crosslink Supported. Read-only. Reset: 0. 1=Crosslink supported.
7:1	SupportedLinkSpeed: Supported Link Speed. Read-only. Reset: 07h. Specifies what link speeds are supported. Bit 1 = 2.5 GT/s, Bit2 = 5.0 Gt/s, Bit 3 = 8.0 GT/s.
0	Reserved.

D1F0x88 Link Control and Status 2

Reset: 0000_0000h.

Bits	Description
31:22	Reserved.
21	LinkEqualizationRequest. Read-only. Set when hardware requests link equalization to be performed.
20	EqualizationPhase3Success: Phase3 of Tx equalization procedure completed. Read-only.
19	EqualizationPhase2Success: Phase2 of Tx equalization procedure completed. Read-only.
18	EqualizationPhase1Success: Phase1 of Tx equalization procedure completed. Read-only.
17	EqualizationComplete: Tx equalization procedure completed. Read-only.
16	CurDeemphasisLevel: current deemphasis level. Read-only. 1=-3.5 dB. 0=-6 dB.
15:13	Reserved.
12	ComplianceDeemphasis: compliance deemphasis. Read-only. This bit defines the deemphasis level used in compliance mode. 1=-3.5 dB. 0=-6 dB.
11	ComplianceSOS: compliance SOS. Read-only. 1=The device transmits skip ordered sets in between the modified compliance pattern.
10	EnterModCompliance: enter modified compliance. Read-only. 1=The device transmits modified compliance pattern.
9:7	XmitMargin: transmit margin. Read-only. This field controls the non-deemphasized voltage level at the transmitter pins.
6	SelectableDeemphasis: selectable deemphasis. Read-only.
5	HwAutonomousSpeedDisable: hardware autonomous speed disable. Read-only. 1=Disables hardware generated link speed changes.
4	EnterCompliance: enter compliance. Read-only. 1=Force link to enter compliance mode.
3:0	TargetLinkSpeed: target link speed. Read-only. This field defines the upper limit of the link operational speed.

D1F0xA0 MSI Capability

Bits	Description
31:24	Reserved.

23	Msi64bit: MSI 64 bit capability. Read-only. Reset: 1. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.
22:20	MsiMultiEn: MSI multiple message enable. Read-write. Reset: 000b. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector.
19:17	MsiMultiCap: MSI multiple message capability. Read-only. Reset: 000b. 000b=The device is requesting one vector.
16	MsiEn: MSI enable. Read-write. Reset: 0. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.
15:8	NextPtr: next pointer. Read-only. Reset:00h
7:0	CapID: capability ID. Read-only. Reset: 05h. 05h=MSI capability structure.

D1F0xA4 MSI Message Address Low

Reset: 0000_0000h.

Bits	Description
31:2	MsiMsgAddrLo: MSI message address. Read-write. This register specifies the dword aligned address for the MSI memory write transaction.
1:0	Reserved.

D1F0xA8 MSI Message Address High

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	MsiMsgAddrHi: MSI message address. Read-write. This register specifies the upper 8-bits of the MSI address in 64 bit MSI mode.

D1F0xAC MSI Message Data

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15:0	MsiData: MSI message data. Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0.

D1F0x100 Vendor Specific Enhanced Capability

Reset: 0061_000Bh.

Bits	Description
31:20	NextPtr: next pointer. Read-only.

19:16	CapVer: capability version. Read-only.
15:0	CapID: capability ID. Read-only.

D1F0x104 Vendor Specific Header

Reset: 0101_0001h.

Bits	Description
31:20	VsecLen: vendor specific enhanced next pointer. Read-only.
19:16	VsecRev: vendor specific enhanced capability version. Read-only.
15:0	VsecID: vendor specific enhanced capability ID. Read-only.

D1F0x108 Vendor Specific 1

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write.

D1F0x10C Vendor Specific 2

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write.

3.6 Device 1 Function 1 (Audio Controller) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D1F1x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: Product-specific.
15:0	VendorID: vendor ID. Read-only. Value: 1002h.

D1F1x04 Status/Command

Reset: 0010_0000h.

Bits	Description
31	ParityErrorDetected: detected parity error. Read; Write-1-to-clear. 1=Poisoned TLP received.
30	SignaledSystemError: signaled system error. Read; Write-1-to-clear. 1=A non-fatal or fatal error message was sent and SerrEn=1.
29	ReceivedMasterAbort: received master abort. Read; Write-1-to-clear. 1=A completion with an unsupported request completion status was received.
28	ReceivedTargetAbort: received target abort. Read; Write-1-to-clear. 1=A completion with completer abort completion status was received.
27	SignalTargetAbort: Signaled target abort. Read-only.
26:25	DevSelTiming: DEVSEL# Timing. Read-only.
24	MasterDataPerr: master data parity error. Read; Write-1-to-clear. 1=ParityErrorEn=1 and either a poisoned completion was received or the device poisoned a write request.
23	FastBackCapable: fast back-to-back capable. Read-only.
22	UDFEn: UDF enable. Read-only.
21	PCI66En: 66 MHz capable. Read-only.
20	CapList: capability list. Read-only. 1=capability list supported.
19	IntStatus: interrupt status. Read-only. 1=INTx interrupt message pending.
18:11	Reserved.
10	IntDis: interrupt disable. Read-write. 1=INTx interrupt messages generation disabled.
9	FastB2BEn: fast back-to-back enable. Read-only.
8	SerrEn: System error enable. Read-write. 1=Enables reporting of non-fatal and fatal errors detected.
7	Stepping: Stepping control. Read-only.
6	ParityErrorEn: parity error response enable. Read-write.
5	PalSnoopEn: VGA palette snoop enable. Read-only.

4	MemWriteInvalidateEn: memory write and invalidate enable. Read-only.
3	SpecialCycleEn: special cycle enable. Read-only.
2	BusMasterEn: bus master enable. Read-write. 1=Memory and IO read and write request generation enabled.
1	MemAccessEn: IO access enable. Read-write. This bit controls if memory accesses targeting this device are accepted. 1=Enabled. 0=Disabled.
0	IoAccessEn: IO access enable. Read-write. This bit controls if IO accesses targeting this device are accepted. 1=Enabled. 0=Disabled.

D1F1x08 Class Code/Revision ID

Reset: 0403_0000h.

Bits	Description
31:8	ClassCode. Read-only.
7:0	RevID: revision ID. Read-only.

D1F1x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:24	BIST. Read-only. These bits are fixed at their default values.
23:16	HeaderTypeReg. Read-only. 80h=Type 0 multi-function device.
15:8	LatencyTimer. Read-only. These bits are fixed at their default value.
7:0	CacheLineSize. Read-write. This field specifies the system cache line size in units of double words.

D1F1x10 Audio Registers Base Address

Reset: 0000_0000h.

Bits	Description
31:14	BaseAddr: base address. Read-write.
13:4	Reserved.
3	Pref: prefetchable. Read-only. 0=Non-prefetchable memory region.
2:1	Type: base address register type. Read-only. 00b=32-bit base address register.
0	MemSpace: memory space type. Read-only. 0=Memory mapped base address.

D1F1x14 Base Address 1

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x18 Base Address 2

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x1C Base Address 3

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x20 Base Address 4

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x24 Base Address 5

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x2C Subsystem and Subvendor IDReset: 0000_0000h. This register can be modified through [D1F1x4C](#).

Bits	Description
31:16	SubsystemID . Read-only.
15:0	SubsystemVendorID . Read-only.

D1F1x30 Expansion ROM Base Address

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D1F1x34 Capabilities Pointer

Reset: 0000_0050h.

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Pointer to PM capability.

D1F1x3C Interrupt Line

Reset: 0000_02FFh.

Bits	Description
31:16	Reserved.
15:8	InterruptPin: interrupt pin. Read-only. This field identifies the legacy interrupt message the function uses.
7:0	InterruptLine: interrupt line. Read-write. This field contains the interrupt line routing information.

D1F1x4C Subsystem and Subvendor ID Mirror

Reset: 0000_0000h.

Bits	Description
31:16	SubsystemID. Read-write. This field sets the value in the corresponding field in D1F1x2C .
15:0	SubsystemVendorID. Read-write. This field sets the value in the corresponding field in D1F1x2C .

D1F1x50 Power Management Capability

Bits	Description
31:27	PmeSupport. Value: 0_0000b. Indicates that there is no PME support.
26	D2Support: D2 support. Value: 1. D2 is supported.
25	D1Support: D1 support. Value: 1. D1 is supported.
24:22	AuxCurrent: auxiliary current. Value: 0.
21	DevSpecificInit: device specific initialization. Value: 0. Indicates that there is no device specific initialization necessary.
20	Reserved.
19	PmeClock. Value: 0.
18:16	Version: version. Value: 011b.
15:8	NextPtr: next pointer. Value: 00h.
7:0	CapID: capability ID. Value: 01h. Indicates that the capability structure is a PCI power management data structure.

D1F1x54 Power Management Control and Status

Reset: 0000_0000h.

Bits	Description								
31:24	PmeData : Read-only.								
23	BusPwrEn : Read-only.								
22	B2B3Support : Read-only. B states are not supported.								
21:16	Reserved.								
15	PmeStatus : PME status . Read-only.								
14:13	DataScale : data scale . Read-only.								
12:9	DataSelect : data select . Read-only.								
8	PmeEn : PME# enable . Read-only.								
7:4	Reserved.								
3	NoSoftReset : no soft reset . Read-only. Software is required to re-initialize the function when returning from D3 _{hot} .								
2	Reserved.								
1:0	PowerState : power state . Read-write. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>D0</td></tr> <tr> <td>10b-01b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>D3hot</td></tr> </table>	Bits	Definition	00b	D0	10b-01b	Reserved	11b	D3hot
Bits	Definition								
00b	D0								
10b-01b	Reserved								
11b	D3hot								

D1F1x58 PCI Express® Capability

Bits	Description
31:30	Reserved.
29:25	IntMessageNum : interrupt message number . Value: 0. This field indicates which MSI vector is used for the interrupt message.
24	SlotImplemented : Slot implemented . Value: 0.
23:20	DeviceType : device type . Value: 9h.
19:16	Version . Value: 2h.
15:8	NextPtr : next pointer . Value: Product-specific.
7:0	CapID : capability ID . Value: 10h.

D1F1x5C Device Capability

Bits	Description
31:29	Reserved.
28	FlrCapable : function level reset capability . Value: Product-specific.
27:26	CapturedSlotPowerScale : captured slot power limit scale . Value: 0.

25:18	CapturedSlotPowerLimit: captured slot power limit value. Value: 0.
17:16	Reserved.
15	RoleBasedErrReporting: role-based error reporting. Value: 1.
14:12	Reserved.
11:9	L1AcceptableLatency: endpoint L1 Acceptable Latency. Value: 111b.
8:6	L0SAcceptableLatency: endpoint L0s Acceptable Latency. Value: 110b.
5	ExtendedTag: extended tag support. Value: 1. 8 bit tag support.
4:3	PhantomFunc: phantom function support. Value: 0. No phantom functions supported.
2:0	MaxPayloadSupport: maximum supported payload size. Value: 000b. 128 bytes max payload size.

D1F1x60 Device Control and Status

Reset: 0000_0810h.

Bits	Description
31:22	Reserved.
21	TransactionsPending: transactions pending. Read-only.
20	AuxPwr: auxiliary power. Read-only.
19	UsrDetected: unsupported request detected. Read; Write-1-to-clear. 1=Unsupported request received.
18	FatalErr: fatal error detected. Read; Write-1-to-clear. 1=Fatal error detected.
17	NonFatalErr: non-fatal error detected. Read; Write-1-to-clear. 1=Non-fatal error detected.
16	CorrErr: correctable error detected. Read; Write-1-to-clear. 1=Correctable error detected.
15	BridgeCfgRetryEn: bridge configuration retry enable. Read-only.
14:12	MaxRequestSize: maximum request size. Read-only. 0=The root port never generates read requests with size exceeding 128 bytes.
11	NoSnoopEnable: enable no snoop. Read-write. 1=The device is permitted to set the No Snoop bit in requests.
10	AuxPowerPmEn: auxiliary power PM enable. Read-only. This capability is not implemented.
9	PhantomFuncEn: phantom functions enable. Read-only. Phantom functions are not supported.
8	ExtendedTagEn: extended tag enable. Read-write. 1=8-bit tag request tags. 0=5-bit request tag.
7:5	MaxPayloadSize: maximum supported payload size. Read-only. 000b=Indicates a 128 byte maximum payload size.
4	RelaxedOrdEn: relaxed ordering enable. Read-write. 1=The device is permitted to set the Relaxed Ordering bit.
3	UsrReportEn: unsupported request reporting enable. Read-write. 1=Enables signaling unsupported requests by sending error messages.
2	FatalErrEn: fatal error reporting enable. Read-write. 1=Enables sending ERR_FATAL message when a fatal error is detected.

1	NonFatalErrEn: non-fatal error reporting enable. Read-write. 1=Enables sending ERR_NONFATAL message when a non-fatal error is detected.
0	CorrErrEn: correctable error reporting enable. Read-write. 1=Enables sending ERR_CORR message when a correctable error is detected.

D1F1x64 Link Capability

Bits	Description
31:24	PortNumber: port number. Value: 0. This field indicates the PCI Express port number for the given PCI Express link.
23:22	Reserved.
21	LinkBWNotificationCap: link bandwidth notification capability. Read-only. Value: 0b.
20	DLActiveReportingCapable: data link layer active reporting capability. Read-only. Value: 0b.
19	SurpriseDownErrReporting: surprise down error reporting capability. Read-only. Value: 0b.
18	ClockPowerManagement: clock power management. Read-only. Value: 0b.
17:15	L1ExitLatency: L1 exit latency. Read-only. Value: 0b.
14:12	L0sExitLatency: L0s exit latency. Read-only. Value: 0b.
11:10	PMSupport: active state power management support. Read-only. Value: 0b.
9:4	LinkWidth: maximum link width. Read-only. Value: 0.
3:0	LinkSpeed: link speed. Read-only. Value: 0b.

D1F1x68 Link Control and Status

Reset: 0000_0000h.

Bits	Description
31	LinkAutonomousBWStatus: link autonomous bandwidth status. Read-only.
30	LinkBWManagementStatus: link bandwidth management status. Read-only.
29	DLActive: data link layer link active. Read-only. This bit indicates the status of the data link control and management state machine. Reads return a 1 to indicate the DL_Active state, otherwise 0 is returned.
28	SlotClockCfg: slot clock configuration. Read-only. 1=The root port uses the same clock that the platform provides.
27	LinkTraining: link training. Read-only. 1=Indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state.
26	Reserved.
25:20	NegotiatedLinkWidth: negotiated link width. Read-only. This field indicates the negotiated width of the given PCI Express link.

19:16	LinkSpeed: link speed. Read-only. <table><tr><td><u>Bits</u></td><td></td><td><u>Description</u></td><td></td></tr><tr><td>0h</td><td></td><td>Reserved</td><td></td></tr><tr><td>1h</td><td></td><td>2.5 Gb/s.</td><td></td></tr><tr><td>2h</td><td></td><td>5 Gb/s.</td><td></td></tr><tr><td>Fh-3h</td><td></td><td>Reserved</td><td></td></tr></table>				<u>Bits</u>		<u>Description</u>		0h		Reserved		1h		2.5 Gb/s.		2h		5 Gb/s.		Fh-3h		Reserved	
<u>Bits</u>		<u>Description</u>																						
0h		Reserved																						
1h		2.5 Gb/s.																						
2h		5 Gb/s.																						
Fh-3h		Reserved																						
15:12	Reserved.																							
11	LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable. Read-only.																							
10	LinkBWManagementEn: link bandwidth management interrupt enable. Read-only.																							
9	HWAutonomousWidthDisable: hardware autonomous width disable. Read-only. 1=Hardware not allowed to change the link width except to correct unreliable link operation by reducing link width.																							
8	ClockPowerManagementEn: clock power management enable. Read-only.																							
7	ExtendedSync: extended sync. Read-only. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.																							
6	CommonClockCfg: common clock configuration. Read-only. 1=Indicates that the root port and the component at the opposite end of this Link are operating with a distributed common reference clock. 0=Indicates that the upstream port and the component at the opposite end of this Link are operating with asynchronous reference clock.																							
5	RetrainLink: retrain link. Read-only. This bit does not apply to endpoints.																							
4	LinkDis: link disable. Read-only. This bit does not apply to endpoints.																							
3	ReadCplBoundary: read completion boundary. Read-only. 0=64 byte read completion boundary.																							
2	Reserved.																							
1:0	PmControl: active state power management enable. Read-only. This field controls the level of ASPM supported on the given PCI Express link. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Disabled.</td><td>10b</td><td>L1 Entry Enabled.</td></tr><tr><td>01b</td><td>L0s Entry Enabled.</td><td>11b</td><td>L0s and L1 Entry Enabled.</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	Disabled.	10b	L1 Entry Enabled.	01b	L0s Entry Enabled.	11b	L0s and L1 Entry Enabled.								
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																					
00b	Disabled.	10b	L1 Entry Enabled.																					
01b	L0s Entry Enabled.	11b	L0s and L1 Entry Enabled.																					

D1F1x7C Device Capability 2

Reset: 0000_0000h.

Bits	Description
31:5	Reserved.
4	CplTimeoutDisSup: completion timeout disable supported. Read-only.
3:0	CplTimeoutRangeSup: completion timeout range supported. Read-only.

D1F1x80 Device Control and Status 2

Reset: 0000_0000h.

Bits	Description
31:5	Reserved.
4	CplTimeoutDis: completion timeout disable. Read-only.
3:0	CplTimeoutValue: completion timeout range supported. Read-only.

D1F1x84 Link Capability 2

Bits	Description
31:0	Reserved.

D1F1x88 Link Control and Status 2

Reset: 0000_0000h.

Bits	Description
31:17	Reserved.
16	CurDeemphasisLevel: current deemphasis level. Read-only. 1=-3.5 dB. 0=-6 dB.
15:13	Reserved.
12	ComplianceDeemphasis: compliance deemphasis. Read-only. This bit defines the deemphasis level used in compliance mode. 1=-3.5 dB. 0=-6 dB.
11	ComplianceSOS: compliance SOS. Read-only. 1=The device transmits skip ordered sets in between the modified compliance pattern.
10	EnterModCompliance: enter modified compliance. Read-only. 1=The device transmits modified compliance pattern.
9:7	XmitMargin: transmit margin. Read-only. This field controls the non-deemphasized voltage level at the transmitter pins.
6	SelectableDeemphasis: selectable deemphasis. Read-only.
5	HwAutonomousSpeedDisable: hardware autonomous speed disable. Read-only. 1=Disables hardware generated link speed changes.
4	EnterCompliance: enter compliance. Read-only. 1=Force link to enter compliance mode.
3:0	TargetLinkSpeed: target link speed. Read-only. This fields defines the upper limit of the link operational speed.

D1F1xA0 MSI Capability

Bits	Description
31:24	Reserved.
23	Msi64bit: MSI 64 bit capability. Read-only. Reset: 1. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.
22:20	MsiMultiEn: MSI multiple message enable. Read-write. Reset: 000b. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector.
19:17	MsiMultiCap: MSI multiple message capability. Read-only. Reset:000b. 000b=The device is requesting one vector.
16	MsiEn: MSI enable. Read-write. Reset: 0. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.
15:8	NextPtr: next pointer. Read-only. Reset: 00h.
7:0	CapID: capability ID. Read-only. Reset: 05h. 05h=MSI capability structure.

D1F1xA4 MSI Message Address Low

Reset: 0000_0000h.

Bits	Description
31:2	MsiMsgAddrLo: MSI message address. Read-write. This register specifies the dword aligned address for the MSI memory write transaction.
1:0	Reserved.

D1F1xA8 MSI Message Address High

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	MsiMsgAddrHi: MSI message address. Read-write. This register specifies the upper 8-bits of the MSI address in 64 bit MSI mode.

D1F1xAC MSI Message Data

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15:0	MsiData: MSI message data. Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0.

D1F1x100 Vendor Specific Enhanced Capability

Reset: 0111_000Bh.

Bits	Description
31:20	NextPtr: next pointer. Read-only.
19:16	CapVer: capability version. Read-only.
15:0	CapID: capability ID. Read-only.

D1F1x104 Vendor Specific Header

Reset: 0101_0001h.

Bits	Description
31:20	VsecLen: vendor specific enhanced next pointer. Read-only.
19:16	VsecRev: vendor specific enhanced capability version. Read-only.
15:0	VsecID: vendor specific enhanced capability ID. Read-only.

D1F1x108 Vendor Specific 1

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write.

D1F1x10C Vendor Specific 2

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write.

3.7 Device 2 Function 0 (Host Bridge) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space. D2F0 registers do not control any hardware. They ensure that software can configure functions 1 through 4.

D2F0x00 Device/Vendor ID (Host Bridge)

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 156Bh.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D2F0x04 Status/Command

Reset: 0000_0000h.

Bits	Description
31:16	Status. Read-only.
15:0	Command. Read-only.

D2F0x08 Class Code/Revision ID

Reset: 0600_0000h.

Bits	Description
31:8	ClassCode: class code. Read-only.
7:0	RevId: revision identifier. Read-only.

D2F0x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:24	Reserved.
23	DeviceType. Read-only. 1=Indicates that the northbridge block is a multi-function device. 0=Indicates that the northbridge block is a single function device.
22:16	HeaderType. Read-only. Indicates multiple functions present in this device.
15:0	Reserved.

D2F0x40 Header Type Write

Reset: 0000_0080h.

Bits	Description
31:8	Reserved.
7	DeviceType . Read-write. This field sets the value in D2F0x0C[DeviceType] . 0=Single function device. 1=Multi-function device.
6:0	Reserved.

3.8 Device 2 Function [5:1] (Root Port) Configuration Registers

See [3.1 \[Register Descriptions and Mnemonics\]](#) for a description of the register naming convention. See [2.7 \[Configuration Space\]](#) for details about how to access this space. See [2.11.1 \[Overview\]](#).

D2F[5:1]x00 Device/Vendor IDTable 110: [Register Mapping](#) for D2F[5:1]x00

D2F[5:1]x00	Function
D2F1x00	GPP Bridge 0
D2F2x00	GPP Bridge 1
D2F3x00	GPP Bridge 2
D2F4x00	GPP Bridge 3
D2F5x00	GPP Bridge 4

Bits	Description
31:16	DeviceID: device ID . Read-only. Value: 1439h.
15:0	VendorID: vendor ID . Read-only. Value: 1022h.

D2F[5:1]x04 Status/Command Register

Reset: 0010_0000h.

Bits	Description
31	ParityErrorDetected: detected parity error . Read; Write-1-to-clear.
30	SignaledSystemError: signaled system error . Read; Write-1-to-clear. 1=System error signalled.
29	ReceivedMasterAbort: received master abort . Read; Write-1-to-clear.
28	ReceivedTargetAbort: received target abort . Read; Write-1-to-clear.
27	SignalTargetAbort: signaled target abort . Read; Write-1-to-clear.
26:25	DevselTiming: DEVSEL# Timing . Read-only.

24	DataPerr: data parity error. Read; Write-1-to-clear.
23	FastBackCapable: fast back-to-back capable. Read-only.
22	Reserved.
21	PCI66En: 66 MHz capable. Read-only.
20	CapList: capability list. Read-only. 1= Capability list present.
19	IntStatus: interrupt status. Read-only. 1=An INTx interrupt Message is pending in the device.
18:11	Reserved.
10	IntDis: interrupt disable. Read-write.
9	FastB2BEn: fast back-to-back enable. Read-only.
8	SerrEn: system error enable. Read-write. 1=System error reporting enabled.
7	Stepping: Stepping control. Read-only.
6	ParityErrorEn: parity error response enable. Read-write.
5	PalSnoopEn: VGA palette snoop enable. Read-only.
4	MemWriteInvalidateEn: memory write and invalidate enable. Read-only.
3	SpecialCycleEn: special cycle enable. Read-only.
2	BusMasterEn: bus master enable. Read-write.
1	MemAccessEn: IO access enable. Read-write. This bit controls if memory accesses targeting this device are accepted or not. 1=Enabled. 0=Disabled.
0	IoAccessEn: IO access enable. Read-write. This bit controls if IO accesses targeting this device are accepted or not. 1=Enabled. 0=Disabled.

D2F[5:1]x08 Class Code/Revision ID Register

Reset: 0604_00xxh.

Bits	Description
31:8	ClassCode. Read-only. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only.

D2F[5:1]x0C Header Type Register

Reset: 0001_0000h.

Bits	Description
31:24	BIST. Read-only. These bits are fixed at their default values.
23	DeviceType. Read-only. 0=Single function device. 1=Multi-function device.
22:16	HeaderType. Read-only. These bits are fixed at their default values. Indicates a Type 0 or Type 1 configuration space.
15:8	LatencyTimer. Read-only. This field does not control any hardware.
7:0	CacheLineSize. Read-write.

D2F[5:1]x18 Bus Number and Secondary Latency Register

Reset: 0000_0000h.

Bits	Description
31:24	SecondaryLatencyTimer: secondary latency timer. Read-only. This field is always 0.
23:16	SubBusNumber: subordinate number. Read-write. This field contains the highest-numbered bus that exists on the secondary side of the bridge.
15:8	SecondaryBus: secondary bus number. Read-write. This field defines the bus number of the secondary bus interface.
7:0	PrimaryBus: primary bus number. Read-write. This field defines the bus number of the primary bus interface.

D2F[5:1]x1C IO Base and Secondary Status Register

Reset: 0000_0101h.

Bits	Description
31	ParityErrorDetected: detected parity error. Read; Write-1-to-clear. A Poisoned TLP was received regardless of the state of the D2F[5:1]x04[ParityErrorEn] .
30	ReceivedSystemError: signaled system error. Read; Write-1-to-clear. 1=A System Error was detected.
29	ReceivedMasterAbort: received master abort. Read; Write-1-to-clear. 1=A CPU transaction is terminated due to a master-abort.
28	ReceivedTargetAbort: received target abort. Read; Write-1-to-clear. 1=A CPU transaction (except for a special cycle) is terminated due to a target-abort.
27	SignalTargetAbort: signaled target abort. Read; Write-1-to-clear.
26:25	DevselTiming: DEVSEL# Timing. Read-only.
24	MasterDataPerr: master data parity error. Read; Write-1-to-clear. 1=The link received a poisoned or poisoned a downstream write and D2F[5:1]x3C[ParityResponseEn] =1.
23	FastBackCapable: fast back-to-back capable. Read-only.
22	Reserved.
21	PCI66En: 66 MHz capable. Read-only.
20	CapList: capability list. Read-only.
19:16	Reserved.
15:12	IOLimit[15:12]. Read-write. Lower part of the limit address. Upper part is defined in D2F[5:1]x30 .
11:8	IOLimitType. Read-only. 0=16-bit. 1=32-bit.
7:4	IOBase[15:12]. Read-write. Lower part of the base address. Upper part is defined in D2F[5:1]x30 .
3:0	IOBaseType. Read-only. 0=16-bit. 1=32-bit.

D2F[5:1]x20 Memory Limit and Base Register

Reset: 0000_0000h.

Bits	Description
31:20	MemLimit[31:20] . Read-write.
19:16	MemLimitType . Read-only. 0=32-bit. 1=64-bit.
15:4	MemBase[31:20] . Read-write.
3:0	MemBaseType . Read-only. 0=32-bit. 1=64-bit.

D2F[5:1]x24 Prefetchable Memory Limit and Base Register

Reset: 0001_0001h.

Bits	Description
31:20	PrefMemLimit . Read-write. Lower part of the limit address. Upper part is defined in D2F[5:1]x2C .
19:16	PrefMemLimitType . Read-only. 0=32-bit. 1=64-bit.
15:4	PrefMemBase[31:20] . Read-write. Lower part of the base address. Upper part is defined in D2F[5:1]x28 .
3:0	PrefMemBaseType . Read-only. 0=32-bit. 1=64-bit.

D2F[5:1]x28 Prefetchable Memory Base High Register

Reset: 0000_0000h.

Bits	Description
31:0	PrefMemBase[63:32] . Read-write. Upper part of the base address. Lower part is defined in D2F[5:1]x24 .

D2F[5:1]x2C Prefetchable Memory Limit High Register

Reset: 0000_0000h.

Bits	Description
31:0	PrefMemLimit[63:32] . Read-write. Upper part of the limit address. Lower part is defined in D2F[5:1]x24 .

D2F[5:1]x30 IO Base and Limit High Register

Reset: 0000_0000h.

Bits	Description
31:16	IOLimit[31:16] . Read-write. Upper part of the limit address. Lower part is defined in D2F[5:1]x1C .
15:0	IOBase[31:16] . Read-write. Upper part of the base address. Lower part is defined in D2F[5:1]x1C .

D2F[5:1]x34 Capabilities Pointer Register

Reset: 0000_0050h.

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Pointer to PM capability.

D2F[5:1]x3C Bridge Control Register

Reset: 0000_00FFh.

Bits	Description
31:24	Reserved.
23	FastB2BCap: Fast back-to-back capability. Read-only.
22	SecondaryBusReset: Secondary bus reset. Read-write. Setting this bit triggers a hot reset on the corresponding PCI Express Port.
21	MasterAbortMode: Master abort mode. Read-only.
20	Vga16En: VGA IO 16 bit decoding enable. Read-write. 1= Address bits 15:10 for VGA IO cycles are decoded. 0=Address bits 15:10 for VGA IO cycles are ignored.
19	VgaEn: VGA enable. Read-write. Affects the response by the bridge to compatible VGA addresses. When it is set, the bridge decodes and forwards the following accesses on the primary interface to the secondary interface: Memory accesses in the range of A_0000h to B_FFFFh and IO address where address bits 9:0 are in the ranges of 3B0h to 3BBh or 3C0h to 3DFh. For IO cycles the decoding of address bits 15:10 depends on Vga16En.
18	IsaEn: ISA enable. Read-write.
17	SerrEn: SERR enable. Read-write.
16	ParityResponseEn: Parity response enable. Read-write. Controls the bridge's response to poisoned TLPs on its secondary interface. 1=The bridge takes its normal action when a poisoned TLP is received. 0=The bridge ignores any poisoned TLPs that it receives and continues normal operation.
15:11	IntPinR: interrupt pin. Read-only.
10:8	IntPin: interrupt pin. IF (D0F0xE4_x0140_0010[HwInitWrLock]==1) THEN Read-only. ELSE Read-write. ENDIF.
7:0	IntLine: Interrupt line. Read-write.

D2F[5:1]x50 Power Management Capability Register

Reset: 0003_5801h.

Bits	Description
31:27	PmeSupport. Read-only.
26	D2Support: D2 support. Read-only. D2 is not supported
25	D1Support: D1 support. Read-only. D1 is not supported
24:22	AuxCurrent: auxiliary current. Read-only. Auxiliary current is not supported.

21	DevSpecificInit: device specific initialization. Read-only. This field is hardwired to 0 to indicate that there is no device specific initialization necessary.
20	Reserved.
19	PmeClock. Read-only. 0=Indicate that PCI clock is not needed to generate PME messages.
18:16	Version: version. Read-only. 3=PMI Spec 1.2
15:8	NextPtr: next pointer. Read-only. 58h=Address of the next capability structure.
7:0	CapID: capability ID. Read-only. 01h=PCI power management data structure.

D2F[5:1]x54 Power Management Control and Status Register

Bits	Description												
31:24	PmiData. Read-only. Reset: 0.												
23	BusPwrEn. Read-only. Reset: 0.												
22	B2B3Support. Read-only. Reset: 0. B states are not supported.												
21:16	Reserved.												
15	PmeStatus: PME status. Read; Write-1-to-clear. Reset: 0. This bit is set when the root port would issue a PME message (independent of the state of the PmeEn bit). Once set, this bit remains set until it is reset by writing a 1 to this bit location. Writing a 0 has no effect.												
14:13	DataScale: data scale. Read-only. Reset: 0.												
12:9	DataSelect: data select. Read-only. Reset: 0.												
8	PmeEn: PME# enable. Read-write. Reset: 0.												
7:4	Reserved.												
3	NoSoftReset: no soft reset. Read-only. Reset: 0. Software is required to re-initialize the function when returning from D3 _{hot} .												
2	Reserved.												
1:0	PowerState: power state. Read-write. Reset: 0. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>D0</td><td>10b</td><td>Reserved</td></tr><tr><td>01b</td><td>Reserved</td><td>11b</td><td>D3</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	D0	10b	Reserved	01b	Reserved	11b	D3
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	D0	10b	Reserved										
01b	Reserved	11b	D3										

D2F[5:1]x58 PCI Express® Capability Register

Reset: 0042_A010h.

Bits	Description
31:30	Reserved.
29:25	IntMessageNum: interrupt message number. Read-only. This register indicates which MSI vector is used for the interrupt message.
24	SlotImplemented: Slot implemented. Read-only. 1=The IO Link associated with this port is connected to a slot.
23:20	DeviceType: device type. Read-only. 4h=Root complex.
19:16	Version. Read-only. 2h=GEN 2 compliant.

15:8	NextPtr: next pointer. Read-only. A0h=Pointer to the next capability structure.
7:0	CapID: capability ID. Read-only. 10h=PCIe® Capability structure.

D2F[5:1]x5C Device Capability Register

Reset: 0000_0020h.

Bits	Description
31:29	Reserved.
28	FlrCapable: function level reset capability. Read-only.
27:26	CapturedSlotPowerScale: captured slot power limit scale. Read-only.
25:18	CapturedSlotPowerLimit: captured slot power limit value. Read-only.
17:16	Reserved.
15	RoleBasedErrReporting: role-based error reporting. Read-only.
14:12	Reserved.
11:9	L1AcceptableLatency: endpoint L1 Acceptable Latency. Read-only.
8:6	L0SAcceptableLatency: endpoint L0s Acceptable Latency. Read-only.
5	ExtendedTag: extended tag support. Read-only. 1: 8 bit tag supported 0: 5 bit tag supported.
4:3	PhantomFunc: phantom function support. Read-only. 0=No phantom functions supported.
2:0	MaxPayloadSupport: maximum supported payload size. Read-only. 000b=128 bytes max payload size.

D2F[5:1]x60 Device Control and Status Register

Reset: 0000_2810h.

Bits	Description
31:22	Reserved.
21	TransactionsPending: transactions pending. Read-only. 0=No internally generated non-posted transactions pending.
20	AuxPwr: auxiliary power. Read-only.
19	UsrDetected: unsupported request detected. Read; Write-1-to-clear. 1=The port received an unsupported request. Errors are logged in this register even if error reporting is disabled.
18	FatalErr: fatal error detected. Read; Write-1-to-clear. 1=The port detected a fatal error. Errors are logged in this register even if error reporting is disabled.
17	NonFatalErr: non-fatal error detected. Read; Write-1-to-clear. 1=The port detected a non-fatal error. Errors are logged in this register even if error reporting is disabled.
16	CorrErr: correctable error detected. Read; Write-1-to-clear. 1=The port detected a correctable error. Errors are logged in this register even if error reporting is disabled.
15	BridgeCfgRetryEn: bridge configuration retry enable. Read-only.
14:12	MaxRequestSize: maximum request size. Read-write.

11	NoSnoopEnable: enable no snoop. Read-write. 1=The port is permitted to set the No Snoop bit in the Requester Attributes of transactions it initiates that do not require hardware enforced cache coherency.																			
10	AuxPowerPmEn: auxiliary power PM enable. Read-only.																			
9	PhantomFuncEn: phantom functions enable. Read-only.																			
8	ExtendedTagEn: extended tag enable. Read-write. 1=8-bit tags generation enabled. 0=5-bit tags are used.																			
7:5	MaxPayloadSize: maximum supported payload size. Read-write. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>0h</td><td>128B</td><td>3h</td><td>1024B</td></tr><tr><td>1h</td><td>256B</td><td>4h</td><td>2048B</td></tr><tr><td>2h</td><td>512B</td><td>5h</td><td>4096B</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	0h	128B	3h	1024B	1h	256B	4h	2048B	2h	512B	5h	4096B
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																	
0h	128B	3h	1024B																	
1h	256B	4h	2048B																	
2h	512B	5h	4096B																	
4	RelaxedOrdEn: relaxed ordering enable. Read-write. 1=The root port is permitted to set the relaxed ordering bit in the attributes field of transactions it initiates that do not require strong write ordering.																			
3	UsrReportEn: unsupported request reporting enable. Read-write. 1=Reporting of unsupported requests enabled.																			
2	FatalErrEn: fatal error reporting enable. Read-write. 1=Enable sending ERR_FATAL messages.																			
1	NonFatalErrEn: non-fatal error reporting enable. Read-write. 1=Enable sending ERR_NONFATAL messages.																			
0	CorrErrEn: correctable error reporting enable. Read-write. 1=Enable sending ERR_CORR messages.																			

D2F[5:1]x64 IO Link Capability Register

Read-only.

Bits	Description
31:24	PortNumber: port number. Reset: 0. This field indicates the port number for the given IO link.
23	Reserved.
22	AspmOptionalityCompliance. Reset: 1. This field indicates if the component supports the ASPM Optionality ECN.
21	LinkBWNotificationCap: link bandwidth notification capability. Reset: 0.
20	DLActiveReportingCapable: data link layer active reporting capability. Reset: 0.
19	SurpriseDownErrReporting. Reset: 0. 1=This field indicates if the component supports the detecting and reporting of a Surprise Down error condition.
18	ClockPowerManagement: clock power management. Reset: 0. 0=Indicates that the reference clock must not be removed while in L1 or L2/L3 ready link states.
17:15	L1ExitLatency: L1 exit latency. Reset: 010b. 010b=Indicate an exit latency between 2 us and 4 us.
14:12	L0sExitLatency: L0s exit latency. Reset: 001b. 001b=Indicates an exit latency between 64 ns and 128 ns.
11:10	PMSupport: active state power management support. Reset: 11b. 11b=Indicates support of L0s and L1.

9:4	LinkWidth: maximum link width. Value: 10h.	
	<u>Bits</u>	<u>Definition</u>
	00h	Reserved.
	01h	1 lanes
	02h	2 lanes
	03h	Reserved.
	04h	4 lanes
	07h-05h	Reserved.
	08h	8 lanes
	0Bh-09h	Reserved.
	0Ch	12 lanes
	0Fh-0Dh	Reserved.
	10h	16 lanes
	1Fh-11h	Reserved.
	20h	32 lanes
	3Fh-21h	Reserved.
3:0	LinkSpeed: link speed. Value: IF (D2F[5:1]xE4_xA4[LcGen2EnStrap]==0) THEN 1h ELSEIF (D2F[5:1]xE4_xA4[LcGen2EnStrap]==1) THEN 2h ENDIF.	
	<u>Bits</u>	<u>Definition</u>
	0h	Reserved.
	1h	2.5 Gb/s
	2h	5.0 Gb/s
	Fh-3h	Reserved.

D2F[5:1]x68 IO Link Control and Status Register

Reset: 1001_0000h.

Bits	Description
31	LinkAutonomousBWStatus: link autonomous bandwidth status. IF (D2F[5:1]x64[LinkBWNotificationCap]==0) THEN Read-only. ELSE Read-write; updated-by-hardware. ENDIF.
30	LinkBWManagementStatus: link bandwidth management status. IF (D2F[5:1]x64[LinkBWNotificationCap]==0) THEN Read-only. ELSE Read-write; updated-by-hardware. ENDIF.
29	DLActive: data link layer link active. Read-only; updated-by-hardware. This bit indicates the status of the data link control and management state machine. 1=DL_Active state. 0=All other states.
28	SlotClockCfg: slot clock configuration. Read-only; updated-by-hardware. 1=The root port uses the same clock that the platform provides.
27	LinkTraining: link training. Read-only; updated-by-hardware. This read-only bit indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state.
26	Reserved.

25:20	<p>NegotiatedLinkWidth: negotiated link width. Read-only; updated-by-hardware. This field indicates the negotiated width of the given PCI Express link.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr><td>00h</td><td>Reserved.</td></tr> <tr><td>01h</td><td>1 lanes</td></tr> <tr><td>02h</td><td>2 lanes</td></tr> <tr><td>03h</td><td>Reserved.</td></tr> <tr><td>04h</td><td>4 lanes</td></tr> <tr><td>07h-05h</td><td>Reserved.</td></tr> <tr><td>08h</td><td>8 lanes</td></tr> <tr><td>0Bh-09h</td><td>Reserved.</td></tr> <tr><td>0Ch</td><td>12 lanes</td></tr> <tr><td>0Fh-0Dh</td><td>Reserved.</td></tr> <tr><td>10h</td><td>16 lanes</td></tr> <tr><td>1Fh-11h</td><td>Reserved.</td></tr> <tr><td>20h</td><td>32 lanes</td></tr> <tr><td>3Fh-21h</td><td>Reserved.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00h	Reserved.	01h	1 lanes	02h	2 lanes	03h	Reserved.	04h	4 lanes	07h-05h	Reserved.	08h	8 lanes	0Bh-09h	Reserved.	0Ch	12 lanes	0Fh-0Dh	Reserved.	10h	16 lanes	1Fh-11h	Reserved.	20h	32 lanes	3Fh-21h	Reserved.
<u>Bits</u>	<u>Definition</u>																														
00h	Reserved.																														
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0Fh-0Dh	Reserved.																														
10h	16 lanes																														
1Fh-11h	Reserved.																														
20h	32 lanes																														
3Fh-21h	Reserved.																														
19:16	<p>LinkSpeed: link speed. Read-only; updated-by-hardware.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr><td>00h</td><td>Reserved.</td></tr> <tr><td>01h</td><td>2.5 Gb/s</td></tr> <tr><td>02h</td><td>5.0 Gb/s</td></tr> <tr><td>Fh-3h</td><td>Reserved.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00h	Reserved.	01h	2.5 Gb/s	02h	5.0 Gb/s	Fh-3h	Reserved.																				
<u>Bits</u>	<u>Definition</u>																														
00h	Reserved.																														
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Fh-3h	Reserved.																														
15:12	Reserved.																														
11	<p>LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable. Read-write. 1=Enables the generation of an interrupt to indicate that the Link AutonomousBWStatus bit has been set.</p>																														
10	<p>LinkBWManagementIntEn: link bandwidth management interrupt enable. Read-write. 1=Enables the generation of an interrupt to indicate that the LinkBWManagementStatus has been set.</p>																														
9	<p>HWAutonomousWidthDisable: hardware autonomous width disable. Read-write. 1=Disables hardware from changing the link width for reasons other than attempting to correct unreliable link operation by reducing link width.</p>																														
8	<p>ClockPowerManagementEn: clock power management enable. Read-write.</p>																														
7	<p>ExtendedSync: extended sync. Read-write. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.</p>																														
6	<p>CommonClockCfg: common clock configuration. Read-write. 1=Indicates that the root port and the component at the opposite end of this IO link are operating with a distributed common reference clock. 0=Indicates that the root port and the component at the opposite end of this IO Link are operating with asynchronous reference clock.</p>																														
5	<p>RetrainLink: retrain link. Read-write; cleared-when-done. 1=Initiate link retraining.</p>																														
4	<p>LinkDis: link disable. Read-write. 1=Disable link. Writes to this bit are immediately reflected in the value read from the bit, regardless of actual link state.</p>																														
3	<p>ReadCplBoundary: read completion boundary. Read-only. 0=64 byte read completion boundary.</p>																														

2	Reserved.			
1:0	PmControl: active state power management enable. Read-write. This field controls the level of ASPM supported on the given IO link.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Disabled.	10b	L1 Entry Enabled.
	01b	L0s Entry Enabled.	11b	L0s and L1 Entry Enabled.

D2F[5:1]x6C Slot Capability Register

Reset: 0004_0000h.

Bits	Description												
31:19	PhysicalSlotNumber: physical slot number. Read-write. This field indicates the physical slot number attached to this port. This field is set to a value that assigns a slot number that is unique within the chassis, regardless of the form factor associated with the slot. This field must be initialized to 0 for ports connected to devices that are on the system board.												
18	NoCmdCplSupport: no command completed support. Read-write. 1 =Indicates that this slot does not generate software notification when an issued command is completed by the hot-plug controller.												
17	ElecMechIIPresent: electromechanical interlock present. Read-write. 0=Indicates that a electro-mechanical interlock is not implemented for this slot.												
16:15	SlotPwrLimitScale: slot power limit scale. Read-write. Specifies the scale used for the SlotPwrLimitValue. Range of Values: <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>1.0</td><td>10b</td><td>0.01</td></tr><tr><td>01b</td><td>0.1</td><td>11b</td><td>0.001</td></tr></table>	Bits	Definition	Bits	Definition	00b	1.0	10b	0.01	01b	0.1	11b	0.001
Bits	Definition	Bits	Definition										
00b	1.0	10b	0.01										
01b	0.1	11b	0.001										
14:7	SlotPwrLimitValue: slot power limit value. Read-write. In combination with the SlotPwrLimitScale value, specifies the upper limit on power supplied by slot. Power limit (in Watts) calculated by multiplying the value in this field by the value in the SlotPwrLimitScale field.												
6	HotplugCapable: hot-plug capability. Read-write.1=Indicates that this slot is capable of supporting hot-plug operations.												
5	HotplugSurprise: hot-plug surprise. Read-write. 1=Indicates that an adapter present in this slot might be removed from the system without any prior notification.												
4	PwrIndicatorPresent: power indicator present. Read-write. 0=Indicates that a power indicator is not implemented for this slot.												
3	AttnIndicatorPresent: attention indicator present. Read-write. 0=Indicates that a attention indicator is not implemented for this slot.												
2	MrlSensorPresent: manual retention latch sensor present. Read-write. 0=Indicates that a manual retention latch sensor is not implemented for this slot.												
1	PwrControllerPresent: power controller present. Read-write. 0=A power controller is not implemented for this slot.												
0	AttnButtonPresent: attention button present. Read-write. 0=An attention button is not implemented for this slot.												

D2F[5:1]x70 Slot Control and Status Register

IF (D2F[5:1]x58[SlotImplemented]==0) THEN Reset: 0040_0000h. ELSE Reset: 0000_0000h. ENDIF.

Bits	Description
31:25	Reserved.
24	DIStateChanged: data link layer state change. Read; Write-1-to-clear. This bit is set when the value reported in the D2F[5:1]x68[DIActive] is changed. In response to a data link layer state changed event, software must read D2F[5:1]x68[DIActive] to determine if the link is active before initiating configuration cycles to the hot plugged device.
23	ElecMechIISts: electromechanical interlock status. Read-only.
22	PresenceDetectState: presence detect state. Read-only. This bit indicates the presence of an adapter in the slot based on the physical layer in-band presence detect mechanism. The in-band presence detect mechanism requires that power be applied to an adapter for its presence to be detected. 0=Slot empty. 1=Card present in slot. For root ports not connected to slots (D2F[5:1]x58[SlotImplemented]=0b), this bit returns always 1.
21	MrlSensorState. Read-only.
20	CmdCpl: command completed. Read-only.
19	PresenceDetectChanged: presence detect changes. Read; Write-1-to-clear. This bit is set when the value reported in PresenceDetectState is changed.
18	MrlSensorChanged. Read; Write-1-to-clear.
17	PwrFaultDetected. Read; Write-1-to-clear.
16	AttnButtonPressed: attention button pressed. Read-only.
15:13	Reserved.
12	DIStateChangedEn: data link layer state changed enable. Read-write. 1=Enables software notification when D2F[5:1]x68[DIActive] is changed.
11	ElecMechIICntl: electromechanical interlock control. Read-only.
10	PwrControllerCntl: power controller control. Read-only.
9:8	PwrIndicatorCntl: power indicator control. Read-only.
7:6	AttnIndicatorControl: attention indicator control. Read-only.
5	HotplugIntrEn: hot-plug interrupt enable. Read-only.
4	CmdCplIntrEn: command complete interrupt enable. Read-only.
3	PresenceDetectChangedEn: presence detect changed enable. Read-only.
2	MrlSensorChangedEn: manual retention latch sensor changed enable. Read-only.
1	PwrFaultDetectedEn: power fault detected enable. Read-only.
0	AttnButtonPressedEn: attention button pressed enable. Read-only.

D2F[5:1]x74 Root Complex Capability and Control Register

Reset: 0001_0000h.

Bits	Description
31:17	Reserved.

16	CrSftSoftVisibility: CRS software visibility. Read-only. 1=Indicates that the root port supports returning configuration request retry status (CRS) completion status to software.
15:5	Reserved.
4	CrSftSoftVisibilityEn: CRS software visibility enable. Read-write. 1=Enables the root port returning configuration request retry status (CRS) completion status to software.
3	PmIntEn: PME interrupt enable. Read-write. 1=Enables interrupt generation upon receipt of a PME message as reflected D2F[5:1]x78[PmeStatus] . A PME interrupt is also generated if D2F[5:1]x78[PmeStatus]=1 and this bit is set by software.
2	SerrOnFatalErrEn: system error on fatal error enable. Read-write. 1=Indicates that a system error should be generated if a fatal error (ERR_FATAL) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself.
1	SerrOnNonFatalErrEn: system error on non-fatal error enable. Read-write. 1=Indicates that a system error should be generated if a non-fatal error (ERR_NONFATAL) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself.
0	SerrOnCorrErrEn: system error on correctable error enable. Read-write. 1=Indicates that a system error should be generated if a correctable error (ERR_COR) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself.

D2F[5:1]x78 Root Complex Status Register

Reset: 0000_0000h.

Bits	Description
31:18	Reserved.
17	PmePending: PME pending. Read-only. This bit indicates that another PME is pending when PmeStatus is set. When PmeStatus is cleared by software; the PME is delivered by hardware by setting the PmeStatus bit again and updating the requestor ID appropriately. PmePending is cleared by hardware if no more PMEs are pending.
16	PmeStatus: pme status. Read; Write-1-to-clear. 1=PME was asserted by the requestor ID indicated in the PmeRequestorID field. Subsequent PMEs are kept pending until PmeStatus is cleared by writing a 1.
15:0	PmeRequestorId: pme requestor ID. Read-only. This field indicates the PCI requestor ID of the last PME requestor.

D2F[5:1]x7C Device Capability 2

Reset: 0000_0000h.

Bits	Description															
31:24	Reserved.															
23:22	MaxEndEndTlpPrefixes: Max number of End-End TLP prefixes supported. Read-only. IF (D2F[5:1]x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>4 End-End TLP Prefixes.</td><td>10b</td><td>2 End-End TLP Prefixes.</td></tr><tr><td>01b</td><td>1 End-End TLP Prefix.</td><td>11b</td><td>3 End-End TLP Prefixes.</td></tr></table>				Bits	Definition	Bits	Definition	00b	4 End-End TLP Prefixes.	10b	2 End-End TLP Prefixes.	01b	1 End-End TLP Prefix.	11b	3 End-End TLP Prefixes.
Bits	Definition	Bits	Definition													
00b	4 End-End TLP Prefixes.	10b	2 End-End TLP Prefixes.													
01b	1 End-End TLP Prefix.	11b	3 End-End TLP Prefixes.													
21	EndEndTlpPrefixSupported: End-End TLP Prefix supported. Read-only.															

20	ExtendedFmtFieldSupported. Read-only. 1=Supports the 3-bit definition of the Fmt field. 0=Supports the 2-bit definition of the Fmt field. BIOS: Must be set for functions that support End-End TLP prefixes.
19:18	ObffSupported: optimized buffer flush/fill supported. Read-only.
17:14	Reserved.
13:12	Reserved.
11	LtrSupported: latency tolerance supported. Read-only.
10	Reserved.
9:6	Reserved.
5	AriForwardingSupported. Read-only.
4	CplTimeoutDisSup: completion timeout disable supported. Read-only.
3:0	CplTimeoutRangeSup: completion timeout range supported. Read-only. Fh=Completion timeout range is 64s to 50us.

D2F[5:1]x80 Device Control and Status 2

Reset: 0000_8000h.

Bits	Description																																
31:16	Reserved.																																
15	EndEndTlpPrefixBlocking. Read-only. 1=Forwarding of End-End TLP Prefixes is not supported. This bit is hardwired to 1b.																																
14:13	ObffEn: optimized buffer flush/fill enable. Read-write.																																
12:11	Reserved.																																
10	LtrEn: latency tolerance reporting enable. Read-write.																																
9	Reserved.																																
8	Reserved.																																
7:6	Reserved.																																
5	AriForwardingEn. Read-write.																																
4	CplTimeoutDis: completion timeout disable. Read-write. 1=Completion timeout disabled.																																
3:0	CplTimeoutValue: completion timeout value. Read-write. BIOS: 6h. <table><tr><td><u>Bits</u></td><td><u>Timeout Range</u></td><td><u>Bits</u></td><td><u>Timeout Range</u></td></tr><tr><td>0h</td><td>50ms-50us</td><td>9h</td><td>900ms-260ms</td></tr><tr><td>1h</td><td>100us-50us</td><td>Ah</td><td>3.5s-1s</td></tr><tr><td>2h</td><td>10ms-1ms</td><td>Ch-Bh</td><td>Reserved</td></tr><tr><td>4h-3h</td><td>Reserved</td><td>Dh</td><td>13s-4s</td></tr><tr><td>5h</td><td>55ms-16ms</td><td>Eh</td><td>64s-4s</td></tr><tr><td>6h</td><td>210ms-65ms</td><td>Fh</td><td>Reserved</td></tr><tr><td>8h-7h</td><td>Reserved</td><td></td><td></td></tr></table>	<u>Bits</u>	<u>Timeout Range</u>	<u>Bits</u>	<u>Timeout Range</u>	0h	50ms-50us	9h	900ms-260ms	1h	100us-50us	Ah	3.5s-1s	2h	10ms-1ms	Ch-Bh	Reserved	4h-3h	Reserved	Dh	13s-4s	5h	55ms-16ms	Eh	64s-4s	6h	210ms-65ms	Fh	Reserved	8h-7h	Reserved		
<u>Bits</u>	<u>Timeout Range</u>	<u>Bits</u>	<u>Timeout Range</u>																														
0h	50ms-50us	9h	900ms-260ms																														
1h	100us-50us	Ah	3.5s-1s																														
2h	10ms-1ms	Ch-Bh	Reserved																														
4h-3h	Reserved	Dh	13s-4s																														
5h	55ms-16ms	Eh	64s-4s																														
6h	210ms-65ms	Fh	Reserved																														
8h-7h	Reserved																																

D2F[5:1]x84 IO Link Capability 2

Bits	Description
31:9	Reserved.
8	CrossLinkSupported . Read-only. Reset: 0.
7:3	Reserved.
2:1	SupportedLinkSpeed . Read-only. Reset: 3h. Specifies the supported link speeds. Bit 1=2.5GT/s, Bit 2=5.0GT/s.
0	Reserved.

D2F[5:1]x88 IO Link Control and Status 2

Bits	Description																								
31:22	Reserved.																								
21	LinkEqualizationRequest . Read; write-1-to-clear. Reset: 0. 1=Hardware requests link equalization to be performed.																								
20	EqualizationPhase3Success . Read-only. Reset: 0. 1=Phase 3 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear.																								
19	EqualizationPhase2Success . Read-only. Reset: 0. 1=Phase 2 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear.																								
18	EqualizationPhase1Success . Read-only. Reset: 0. 1=Phase 1 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear.																								
17	EqualizationComplete . Read-only. Reset: 0. 1=Transmitter Equalization procedure has completed. Write 1 to clear.																								
16	CurDeemphasisLevel: current deemphasis level . Read-only. Reset: D2F[5:1]xE4_xA4[LcGen2EnStrap] . 1=-3.5 dB. 0=-6 dB																								
15:12	<p>ComplianceDeemphasis: compliance deemphasis. Read-write. Reset: 0. In Gen2, this field defines the compliance deemphasis level when EnterCompliance is set. Software should leave this field in its default state.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>DeEmph=-6 dB, Preshoot=0 dB</td></tr> <tr> <td>1h</td><td>DeEmph=-3.5 dB, Preshoot=0 dB</td></tr> <tr> <td>2h</td><td>DeEmph=-4.5 dB, Preshoot=0 dB</td></tr> <tr> <td>3h</td><td>DeEmph=-2.5 dB, Preshoot=0 dB</td></tr> <tr> <td>4h</td><td>DeEmph=-0 dB, Preshoot=0 dB</td></tr> <tr> <td>5h</td><td>DeEmph=-0 dB, Preshoot=2 dB</td></tr> <tr> <td>6h</td><td>DeEmph=-0 dB, Preshoot=2.5 dB</td></tr> <tr> <td>7h</td><td>DeEmph=-6 dB, Preshoot=3.5 dB</td></tr> <tr> <td>8h</td><td>DeEmph=-3.5 dB, Preshoot=3.5 dB</td></tr> <tr> <td>9h</td><td>DeEmph=-0 dB, Preshoot=3.5 dB</td></tr> <tr> <td>Fh-Ah</td><td>Reserved.</td></tr> </table>	Bits	Definition	0h	DeEmph=-6 dB, Preshoot=0 dB	1h	DeEmph=-3.5 dB, Preshoot=0 dB	2h	DeEmph=-4.5 dB, Preshoot=0 dB	3h	DeEmph=-2.5 dB, Preshoot=0 dB	4h	DeEmph=-0 dB, Preshoot=0 dB	5h	DeEmph=-0 dB, Preshoot=2 dB	6h	DeEmph=-0 dB, Preshoot=2.5 dB	7h	DeEmph=-6 dB, Preshoot=3.5 dB	8h	DeEmph=-3.5 dB, Preshoot=3.5 dB	9h	DeEmph=-0 dB, Preshoot=3.5 dB	Fh-Ah	Reserved.
Bits	Definition																								
0h	DeEmph=-6 dB, Preshoot=0 dB																								
1h	DeEmph=-3.5 dB, Preshoot=0 dB																								
2h	DeEmph=-4.5 dB, Preshoot=0 dB																								
3h	DeEmph=-2.5 dB, Preshoot=0 dB																								
4h	DeEmph=-0 dB, Preshoot=0 dB																								
5h	DeEmph=-0 dB, Preshoot=2 dB																								
6h	DeEmph=-0 dB, Preshoot=2.5 dB																								
7h	DeEmph=-6 dB, Preshoot=3.5 dB																								
8h	DeEmph=-3.5 dB, Preshoot=3.5 dB																								
9h	DeEmph=-0 dB, Preshoot=3.5 dB																								
Fh-Ah	Reserved.																								
11	ComplianceSOS: compliance SOS . Read-write. Reset: 0. 1=The device transmits skip ordered sets in between the modified compliance pattern.																								

10	EnterModCompliance: enter modified compliance. Read-write. Reset: 0. 1=The device transmits modified compliance pattern. Software should leave this field in its default state.										
9:7	XmitMargin: transmit margin. Read-write. Reset: 0. This field controls the non-deemphasized voltage level at the transmitter pins. Software should leave this field in its default state.										
6	SelectableDeemphasis: selectable deemphasis. Read-only. Reset: D2F[5:1]xE4_xA4[LcGen2EnStrap] . 0=Selectable deemphasis is not supported. 1=Selectable deemphasis supported.										
5	HwAutonomousSpeedDisable: hardware autonomous speed disable. Read-write. Cold reset: 0. 1=Support for hardware changing the link speed for device specific reasons disabled.										
4	EnterCompliance: enter compliance. Read-write. Cold reset: 0. 1=Force the link to enter the compliance mode.										
3:0	<p>TargetLinkSpeed: target link speed. Read-write. Reset: 2h. This field defines the upper limit of the link operational speed. Writes of reserved encodings are not valid. Hardware prevents writes of reserved encodings from changing the state of this field.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>1h</td><td>2.5GT/s</td></tr> <tr> <td>2h</td><td>5.0GT/s</td></tr> <tr> <td>Fh-3h</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0h	Reserved	1h	2.5GT/s	2h	5.0GT/s	Fh-3h	Reserved
<u>Bits</u>	<u>Definition</u>										
0h	Reserved										
1h	2.5GT/s										
2h	5.0GT/s										
Fh-3h	Reserved										

D2F[5:1]x8C Slot Capability 2

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D2F[5:1]x90 Slot Control and Status 2

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D2F[5:1]xA0 MSI Capability Register

Reset: 0000_B005h.

Bits	Description
31:24	Reserved.
23	Msi64bit: MSI 64 bit capability. Read-only. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.
22:20	MsiMultiEn: MSI multiple message enable. Read-write. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector.

19:17	MsiMultiCap: MSI multiple message capability. Read-only. 000b=The device is requesting one vector.
16	MsiEn: MSI enable. Read-write. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.
15:8	NextPtr: next pointer. Read-only.
7:0	CapID: capability ID. Read-only. 05h=MSI capability structure.

D2F[5:1]x4 MSI Message Address Low

Reset: 0000_0000h.

Bits	Description
31:2	MsiMsgAddrLo: MSI message address. Read-write. This register specifies the dword aligned address for the MSI memory write transaction.
1:0	Reserved.

D2F[5:1]x8 MSI Message Address High

Reset: 0000_0000h.

Bits	Description
31:0	MsiMsgAddrHi: MSI message address. Read-write. This register specifies the upper 32-bits of the MSI address.

D2F[5:1]x4C MSI Message Data

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15:0	MsiData: MSI message data. Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0.

D2F[5:1]xB0 Subsystem and Subvendor Capability ID Register

Reset: 0000_B80Dh.

Bits	Description
31:16	Reserved.
15:8	NextPtr: next pointer. Read-only.
7:0	CapID: capability ID. Read-only.

D2F[5:1]xB4 Subsystem and Subvendor ID Register

Reset: 0000_0000h.

Bits	Description
31:16	SubsystemID . Read-only.
15:0	SubsystemVendorID . Read-only.

D2F[5:1]xB8 MSI Capability Mapping

Reset: A803_0008h.

Bits	Description
31:27	CapType: capability type . Read-only.
26:18	Reserved.
17	FixD . Read-only.
16	En . Read-only.
15:8	NextPtr: next pointer . Read-only.
7:0	CapID: capability ID . Read-only.

D2F[5:1]xBC MSI Mapping Address Low

Bits	Description
31:20	MsiMapAddrLo . Read-only. Reset: 0. Lower 32-bits of the MSI address.
19:0	Reserved.

D2F[5:1]xC0 MSI Mapping Address High

Bits	Description
31:0	MsiMapAddrHi . Read-only. Reset: 0. Upper 32-bits of the MSI address.

D2F[5:1]xE0 Root Port Index

Reset: 0000_0000h.

The index/data pair registers, [D2F\[5:1\]xE0](#) and [D2F\[5:1\]xE4](#), are used to access the registers at [D2F\[5:1\]xE4_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D2F\[5:1\]xE0](#), and then the data is read from or written to the data register, [D2F\[5:1\]xE4](#).

Bits	Description
31:8	Reserved.
7:0	PcieIndex . Read-write.

D2F[5:1]xE4 Root Port Data

See [D2F\[5:1\]xE0](#). Address: [D2F\[5:1\]xE0\[PCIEINDEX\]](#).

Bits	Description
31:0	PcieData . Read-write.

D2F[5:1]xE4_x20 Root Port TX Control

Reset: 0050_8000h.

Bits	Description
31:16	Reserved.
15	TxFlushTlpDis: TLP flush disable . Read-write. 1=Disable flushing TLPs when the link is down.
14:0	Reserved.

D2F[5:1]xE4_x50 Root Port Lane Status

Reset: 0000_0000h.

Bits	Description			
31:7	Reserved.			
6:1	PhyLinkWidth: port link width. Read-only; updated-by-hardware.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00_0000b	disabled	00_1000b	x8
	00_0001b	x1	01_0000b	x12
	00_0010b	x2	10_0000b	x16
	00_0100b	x4		
0	PortLaneReversal: port lane reversal. Read-only. 1=Port lanes order is reversed.			

D2F[5:1]xE4_x6A Root Port Error Control

Reset: 0000_0500h.

Bits	Description
31:1	Reserved.
0	ErrReportingDis: advanced error reporting disable . Read-write. BIOS: 1. 1=Error reporting disabled. 0=Error reporting enabled.

D2F[5:1]xE4_x70 Root Port Receiver Control

Reset: 0188_4000h.

Bits	Description
31:20	Reserved.
19	RxRcbCplTimeoutMode: RCB completion timeout mode . Read-write. BIOS: 1. 1=Timeout on link down.

18:16	RxRcbCplTimeout: RCB completion timeout. Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	Disabled	100b	50ms
	001b	50us	101b	100ms
	010b	10ms	110b	500ms
	011b	25ms	111b	1ms
15:0	Reserved.			

D2F[5:1]xE4_xA0 Per Port Link Controller (LC) Control

Reset: 4000_0030h.

Bits	Description			
31:24	Reserved.			
23	LcL1ImmediateAck: immediate ACK ASPM L1 entry. Read-write. BIOS: 1. 1=Always ACK ASPM L1 entry DLLPs.			
22:16	Reserved.			
15:12	LcL1Inactivity: L1 inactivity timer. Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	L1 disabled	8h	400us
	1h	1us	9h	1ms
	2h	2us	Ah	40us
	3h	4us	Bh	10ms
	4h	10us	Ch	40ms
	5h	20us	Dh	100ms
	6h	40us	Eh	400ms
	7h	100us	Fh	reserved
11:8	LcL0sInactivity: L0s inactivity timer. Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	L0s disabled	8h	4us
	1h	40ns	9h	10us
	2h	80ns	Ah	40us
	3h	120ns	Bh	100us
	4h	200ns	Ch	400us
	5h	400ns	Dh	1ms
	6h	1us	Eh	4ms
	7h	2us	Fh	reserved
7:4	Lc16xClearTxPipe. Read-write. BIOS: 3h. Specifies the number of clock to drain the TX pipe.			
3:0	Reserved.			

D2F[5:1]xE4_xA1 LC Training Control

Reset: 9400_1880h.

Bits	Description
31:12	Reserved.

11	LcDontGotoL0sifL1Armed: prevent Ls0 entry is L1 request in progress. Read-write. BIOS: 1. 1=Prevent the LTSSM from transitioning to Rcv_L0s if an acknowledged request to enter L1 is in progress.
10:0	Reserved.

D2F[5:1]xE4_xA2 LC Link Width Control

Reset: 00A0_0006h.

Bits	Description																				
31:24	Reserved.																				
23	Reserved.																				
22:21	LcDynLanesPwrState: unused link power state. Read-write. Controls the state of unused links after a reconfiguration. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>on</td><td>10b</td><td>SB2</td></tr><tr><td>01b</td><td>SB1</td><td>11b</td><td>Off</td></tr></table>	Bits	Definition	Bits	Definition	00b	on	10b	SB2	01b	SB1	11b	Off								
Bits	Definition	Bits	Definition																		
00b	on	10b	SB2																		
01b	SB1	11b	Off																		
20	LcUpconfigCapable: upconfigure capable. Read-only; updated-by-hardware. 1=Both ends of the link are upconfigure capable. 0=Both ends of the link are not upconfigure capable.																				
19:14	Reserved.																				
13	LcUpconfigureDis: upconfigure disable. Read-write. 1=Disable link upconfigure.																				
12	LcUpconfigureSupport: upconfigure support. Read-write.																				
11	LcShortReconfigEn: short re-configuration enable. Read-write. 1=Enable short link re-configuration																				
10	LcRenegotiateEn: link reconfiguration enable. Read-write. 1=Enable link re-negotiation.																				
9	LcRenegotiationSupport: re-negotiation support. Read-only; updated-by-hardware. 1=Link re-negotiation not supported by the downstream device.																				
8	LcReconfigNow: re-configure link. Read-write; cleared-when-done. 1=Initiate link width change.																				
7	LcReconfigArcMissingEscape. Read-write. 1=Expedite transition from Recovery.Idle to Detect during a long reconfiguration.																				
6:4	LcLinkWidthRd: current link width. Read-only; updated-by-hardware. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>0</td><td>100b</td><td>8</td></tr><tr><td>001b</td><td>1</td><td>101b</td><td>12</td></tr><tr><td>010b</td><td>2</td><td>110b</td><td>16</td></tr><tr><td>011b</td><td>4</td><td>111b</td><td>Reserved</td></tr></table>	Bits	Definition	Bits	Definition	000b	0	100b	8	001b	1	101b	12	010b	2	110b	16	011b	4	111b	Reserved
Bits	Definition	Bits	Definition																		
000b	0	100b	8																		
001b	1	101b	12																		
010b	2	110b	16																		
011b	4	111b	Reserved																		
3	Reserved.																				
2:0	LcLinkWidth: link width required. Read-write. See: LcLinkWidthRd.																				

D2F[5:1]xE4_xA3 LC Number of FTS Control

Reset: 00FF_020Ch.

Bits	Description
31:10	Reserved.

9	LcXmitFtsBeforeRecovery: transmit FTS before recovery. Read-write. 1=Transmit FTS before recovery.
8:0	Reserved.

D2F[5:1]xE4_xA4 LC Link Speed Control

Reset: 3440_0100h.

Bits	Description
31:28	Reserved.
27	LcMultUpstreamAutoSpdChngEn: enable multiple automatic speed changes. Read-write. 1=Enable multiple automatic speed changes when D2F[5:1]xE4_xC0[StrapAutoRcSpeedNegotiationDis]=0 and no failures occurred in previous speed change attempts.
26:20	Reserved.
19	LcOtherSideSupportsGen2: downstream link supports gen2. Read-only; updated-by-hardware. 1=The downstream link currently supports gen2.
18:15	Reserved.
14:13	Reserved.
12	LcSpeedChangeAttemptFailed: speed change attempt failed. Read-only; updated-by-hardware. 1=LcSpeedChangeAttemptsAllowed has been reached.
11:10	Reserved.
9	LcInitiateLinkSpeedChange: initiate link speed change. Read-write; cleared-when-done. 1=Initiate link speed negotiation.
8:7	Reserved.
6	LcForceDisSwSpeedChange: force disable software speed changes. Read-write. 1=Force the PCIe core to disable speed changes initiated by private registers.
5:1	Reserved.
0	LcGen2EnStrap: Gen2 PCIe support enable. Read-write. 1=Gen2 PCIe support enabled. 0=Gen2 PCIe support disabled.

D2F[5:1]xE4_xA5 LC State 0

Cold reset: 0000_0000h.

Bits	Description
31:30	Reserved.
29:24	LcPrevState3: previous link state 3. Read-only; updated-by-hardware. See: Table 111 [Link controller state encodings] .
23:22	Reserved.
21:16	LcPrevState2: previous link state 2. Read-only; updated-by-hardware. See: Table 111 [Link controller state encodings]
15:14	Reserved.

13:8	LcPrevState1: previous link state 1. Read-only; updated-by-hardware. See: Table 111 [Link controller state encodings] .
7:6	Reserved.
5:0	LcCurrentState: current link state. Read-only; updated-by-hardware. See: Table 111 [Link controller state encodings] .

Table 111: Link controller state encodings

Bits	Description	Bits	Description	Bits	Description
00h	s_Detect_Quiet.	12h	Rcv_L0_and_Tx_L0s.	24h	s_Rcvd_Loopback.
01h	s_Start_common_Mode.	13h	Rcv_L0_and_Tx_L0s_FTS.	25h	s_Rcvd_Loopback_Idle.
02h	s_Check_Common_Mode.	14h	Rcv_L0s_and_Tx_L0.	26h	s_Rcvd_Reset_Idle.
03h	s_Rcvr_Detect.	15h	Rcv_L0s_and_Tx_L0_Idle.	27h	s_Rcvd_Disable_Entry.
04h	s_No_Rcvr_Loop	16h	Rcv_L0s_and_Tx_L0s.	28h	s_Rcvd_Disable_Idle.
05h	s_Poll_Quiet.	17h	Rcv_L0s_and_Tx_L0s_FTS.	29h	s_Rcvd_Disable.
06h	s_Poll_Active.	18h	s_L1_Entry.	2Ah	s_Detect_Idle.
07h	s_Poll_Compliance.	19h	s_L1_Idle.	2Bh	s_L23_Wait.
08h	s_Poll_Config.	1Ah	s_L1_Wait	2Ch	Rcv_L0s_Skp_and_Tx_L0.
09h	s_Config_Step1.	1Bh	s_L1.	2Dh	Rcv_L0s_Skp_and_Tx_L0_Idle.
0Ah	s_Config_Step3.	1Ch	s_L23_Stall.	2Eh	Rcv_L0s_Skp_and_Tx_L0s.
0Bh	s_Config_Step5.	1Dh	s_L23_Entry.	2Fh	Rcv_L0s_Skp_and_Tx_L0_FTS.
0Ch	s_Config_Step2.	1Eh	s_L23_Entry.	30h	s_Config_Step2b.
0Dh	s_Config_Step4.	1Fh	s_L23_Ready.	31h	s_Recovery_Speed.
0Eh	s_Config_Step6.	20h	s_Recovery_lock.	32h	s_Poll_Compliance_Idle.
0Fh	s_Config_Idle.	21h	s_Recovery_Config.	33h	s_Rcvd_Loopback_Speed.
10h	Rcv_L0_and_Tx_L0.	22h	s_Recovery_Idle.	3Fh-34h	Reserved.
11h	Rcv_L0_and_Tx_L0_Idle.	23h	s_Training_Bit.		

D2F[5:1]xE4_xB1 LC Control 2

Reset: 8608_0280h.

Bits	Description
31:21	Reserved.
20	LcBlockElIdleInL0: block electrical idle in l0. Read-write. BIOS: 1. 1=Prevent electrical idle from causing the receiver to transition from L0 to L0s.
19	LcDeassertRxEnInL0s: deassert RX_EN in L0s. Read-write. 1=Turn off transmitters in L0s.
18:14	Reserved.
13:0	Reserved.

D2F[5:1]xE4_xB5 LC Control 3

Reset: 2850_5020h.

Bits	Description										
31	Reserved.										
30	LcGoToRecovery: go to recovery. Read-write. 1=Force link in the L0 state to transition to the Recovery state.										
29:4	Reserved.										
3	LcRcvdDeemphasis: received deemphasis. Read-only; updated-by-hardware. Deemphasis advertised by the downstream device. 1=3.5dB. 0=6dB.										
2:1	LcSelectDeemphasisCntl: deemphasis control. Read-write. Specifies the deemphasis used by the transmitter. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Use deemphasis from LcSelectDeemphasis.</td></tr> <tr> <td>01b</td><td>Use deemphasis advertised by the downstream device.</td></tr> <tr> <td>10b</td><td>6dB</td></tr> <tr> <td>11b</td><td>3.5dB</td></tr> </table>	Bits	Definition	00b	Use deemphasis from LcSelectDeemphasis.	01b	Use deemphasis advertised by the downstream device.	10b	6dB	11b	3.5dB
Bits	Definition										
00b	Use deemphasis from LcSelectDeemphasis.										
01b	Use deemphasis advertised by the downstream device.										
10b	6dB										
11b	3.5dB										
0	LcSelectDeemphasis: downstream deemphasis. Read-write. Specifies the downstream deemphasis. 1=3.5dB. 0=6dB.										

D2F[5:1]xE4_xC0 LC Strap Override

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15	StrapAutoRcSpeedNegotiationDis: autonomous speed negotiation disable strap override. Read-write. 1=Disable autonomous root complex speed negotiation to Gen2.
14	Reserved.
13	StrapForceCompliance: force compliance strap override. Read-write.
12:0	Reserved.

D2F[5:1]xE4_xC1 Root Port Miscellaneous Strap Override

Reset: 0000_0000h.

Bits	Description
31:6	Reserved.
5	StrapLtrSupported. Read-write.
4:3	StrapObffSupported. Read-write.
2	StrapExtendedFmtSupported: Extended Fmt Supported strap override. Read-write.

1	StrapE2EPrefixEn: E2E Prefix En strap override. Read-write.
0	StrapReverseLanes: reverse lanes strap override. Read-write.

D2F[5:1]xE4_xD0 Root Port ECC Skip OS Feature

Reset: 0000_0100h.

Bits	Description
31:16	BchEccErrorStatus. Read-write. Indicates that lane errors are above the specified threshold. (One bit per lane.)
15:8	BchEccErrorThreshold. Read-write. Error threshold.
7:1	Reserved.
0	StrapBchEccEn. Read-write.

D2F[5:1]x100 Vendor Specific Enhanced Capability Register

Bits	Description
31:20	NextPtr: next pointer. Read-only. IF (D0F0xE4_x0140_00B0[StrapF0AerEn] == 1) THEN Reset: 150h. ELSE Reset: 000h. ENDIF.
19:16	CapVer: capability version. Read-only. Reset: 1h.
15:0	CapID: capability ID. Read-only. Reset: Bh.

D2F[5:1]x104 Vendor Specific Header Register

Reset: 0101_0001h.

Bits	Description
31:20	VsecLen: vendor specific enhanced capability structure length. Read-only. Defined the number of bytes of the entire vendor specific enhanced capability structure including the header.
19:16	VsecRev: vendor specific enhanced capability version. Read-only.
15:0	VsecID: vendor specific enhanced capability ID. Read-only.

D2F[5:1]x108 Vendor Specific 1 Register

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write. This field does not control any hardware.

D2F[5:1]x10C Vendor Specific 2 Register

Reset: 0000_0000h.

Bits	Description
31:0	Scratch: scratch. Read-write. This field does not control any hardware.

D2F[5:1]x128 Virtual Channel 0 Resource Status Register

Reset: 0002_0000h.

Bits	Description
31:18	Reserved.
17	VcNegotiationPending: virtual channel negotiation pending. Read-only; updated-by-hardware. 1=Virtual channel negotiation in progress. This bit must be 0 before the virtual channel can be used.
16	PortArbTableStatus: port arbitration table status. Read-only.
15:0	Reserved.

D2F[5:1]x150 Advanced Error Reporting Capability

Bits	Description
31:20	NextPtr: next pointer. Read-only. IF (D0F0xE4_x0140_00B0[StrapF0AcsEn] == 1) THEN 2A0h. ELSE Reset: 000h. ENDIF.
19:16	CapVer: capability version. Read-only. Reset: 2h.
15:0	CapID: capability ID. Read-only. Reset: 1h.

D2F[5:1]x154 Uncorrectable Error Status

Cold reset: 0000_0000h.

Bits	Description
31:26	Reserved.
25	TlpPrefixStatus: TLP prefix blocked status. Read; Write-1-to-clear.
24	AtomicOpEgressBlockedTLPStatus: atomic op egress blocked TLP status. Read; Write-1-to-clear.
23	McBlockedTLPStatus: MC blocked TLP status. Read; Write-1-to-clear.
22	UncorrInternalErrStatus: uncorrectable internal error status. Read; Write-1-to-clear.
21	AcsViolationStatus: access control service status. Read; Write-1-to-clear.
20	UnsuppReqErrStatus: unsupported request error status. Read; Write-1-to-clear. The header of the unsupported request is logged.
19	EcrcErrStatus: end-to-end CRC error status. Read; Write-1-to-clear.

18	MalTlpStatus: malformed TLP status. Read; Write-1-to-clear. The header of the malformed TLP is logged.
17	RcvOvflStatus: receiver overflow status. Read-only.
16	UnexpCplStatus: unexpected completion timeout status. Read; Write-1-to-clear. The header of the unexpected completion is logged.
15	CplAbortErrStatus: completer abort error status. Read; Write-1-to-clear.
14	CplTimeoutStatus: completion timeout status. Read; Write-1-to-clear.
13	FcErrStatus: flow control error status. Read-only.
12	PsnErrStatus: poisoned TLP status. Read; Write-1-to-clear. The header of the poisoned transaction layer packet is logged.
11:6	Reserved.
5	SurprdnErrStatus: surprise down error status. Read-only. 0=Detection and reporting of surprise down errors is not supported.
4	DlpErrStatus: data link protocol error status. Read; Write-1-to-clear.
3:0	Reserved.

D2F[5:1]x158 Uncorrectable Error Mask

Cold reset: 0000_0000h.

Bits	Description
31:26	Reserved.
25	TlpPrefixMask: TLP prefix blocked mask. Read-only.
24	AtomicOpEgressBlockedTLPMask: atomic op egress blocked TLP mask. Read-only.
23	McBlockedTLPMask: MC blocked TLP mask. Read-only.
22	UncorrInternalErrMask: uncorrectable internal error mask. Read-write.
21	AcsViolationMask: access control service mask. Read-only. 1=ACS violation errors are not reported.
20	UnsuppReqErrMask: unsupported request error mask. Read-write. 1=Unsupported request errors are not reported.
19	EcrcErrMask: end-to-end CRC error mask. Read-write.
18	MalTlpMask: malformed TLP mask. Read-write. 1=Malformed TLP errors are not reported.
17	RcvOvflMask: receiver overflow mask. Read-only.
16	UnexpCplMask: unexpected completion timeout mask. Read-write. 1=Unexpected completion errors are not reported.
15	CplAbortErrMask: completer abort error mask. Read-write.
14	CplTimeoutMask: completion timeout mask. Read-write. 1=Completion timeout errors are not reported.
13	FcErrMask: flow control error mask. Read-only.
12	PsnErrMask: poisoned TLP mask. Read-write. 1=Poisoned TLP errors are not reported.
11:6	Reserved.
5	SurprdnErrMask: surprise down error mask. Read-only.

4	DlpErrMask: data link protocol error mask. Read-write. 1=Data link protocol errors are not reported.
3:0	Reserved.

D2F[5:1]x15C Uncorrectable Error Severity

Cold reset: 0006_2030h.

Bits	Description
31:26	Reserved.
25	TlpPrefixSeverity: TLP prefix blocked severity. Read-only.
24	AtomicOpEgressBlockedTLPSeverity: atomic op egress blocked TLP severity. Read-only.
23	McBlockedTLPSeverity: MC blocked TLP severity. Read-only.
22	UncorrInternalErrSeverity: uncorrectable internal error severity. Read-only.
21	AcsViolationSeverity: access control service severity. Read-only. 1=Fatal error. 0=Non-fatal error.
20	UnsuppReqErrSeverity: unsupported request error severity. Read-write. 1=Fatal error. 0=Non-fatal error.
19	EcrcErrSeverity: end-to-end CRC error severity. Read-only.
18	MalTlpSeverity: malformed TLP severity. Read-write. 1=Fatal error. 0=Non-fatal error.
17	RcvOvflSeverity: receiver overflow severity. Read-only.
16	UnexpCplSeverity: unexpected completion timeout severity. Read-write. 1=Fatal error. 0=Non-fatal error.
15	CplAbortErrSeverity: completer abort error severity. Read-only.
14	CplTimeoutSeverity: completion timeout severity. Read-write. 1=Fatal error. 0=Non-fatal error.
13	FcErrSeverity: flow control error severity. Read-only.
12	PsnErrSeverity: poisoned TLP severity. Read-write. 1=Fatal error. 0=Non-fatal error.
11:6	Reserved.
5	SurprdnErrSeverity: surprise down error severity. Read-only.
4	DlpErrSeverity: data link protocol error severity. Read-write. 1=Fatal error. 0=Non-fatal error.
3:0	Reserved.

D2F[5:1]x160 Correctable Error Status

Cold reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15	HdrLogOvflStatus: header log overflow status. Read-only.
14	CorrIntErrStatus: corrected internal error status. Read; Write-1-to-clear.
13	AdvisoryNonfatalErrStatus: advisory non-fatal error status. Read; Write-1-to-clear. 1=A non-fatal unsupported request errors or a non-fatal unexpected completion errors occurred.
12	ReplayTimerTimeoutStatus: replay timer timeout status. Read; Write-1-to-clear.
11:9	Reserved.

8	ReplayNumRolloverStatus: replay. Read; Write-1-to-clear. 1=The same transaction layer packet has been replayed three times and has caused the link to re-train.
7	BadDllpStatus: bad data link layer packet status. Read; Write-1-to-clear. 1=A link CRC error was detected.
6	BadTlpStatus: bad transaction layer packet status. Read; Write-1-to-clear. 1=A bad non-duplicated sequence ID or a link CRC error was detected.
5:1	Reserved.
0	RcvErrStatus: receiver error status. Read-only. 1=An 8B10B or disparity error was detected.

D2F[5:1]x164 Correctable Error Mask

Cold reset: 0000_6000h.

Bits	Description
31:16	Reserved.
15	HdrLogOvfMask: header log overflow mask. Read-only.
14	CorrIntErrMask: corrected internal error mask. Read-write.
13	AdvisoryNonfatalErrMask: advisory non-fatal error mask. Read-write. 1=Error is not reported.
12	ReplayTimerTimeoutMask: replay timer timeout mask. Read-write. 1=Error is not reported.
11:9	Reserved.
8	ReplayNumRolloverMask: replay. Read-write. 1=Error is not reported.
7	BadDllpMask: bad data link layer packet mask. Read-write. 1=Error is not reported.
6	BadTlpMask: bad transaction layer packet mask. Read-write. 1=Error is not reported.
5:1	Reserved.
0	RcvErrMask: receiver error mask. Read-only. 1=Error is not reported.

D2F[5:1]x168 Advanced Error Control

Cold reset: 0000_0000h.

Bits	Description
31:12	Reserved.
11	TlpPrefixLogPresent. Read-only. IF (D2F[5:1]x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF. 1=If FirstErrPtr is valid then the TLP Prefix Log register contains valid information.
10	MultiHdrRecdEn. Read-only. 1=Enables recording more than one error header.
9	MultiHdrRecdCap. Read-only. 1=Specifies that the function is capable of recording more than one error header.
8	EcrcCheckEn: data link protocol error severity. Read-write. 0=Specifies that End-to-end CRC generation is not supported.
7	EcrcCheckCap: data link protocol error severity. Read-only. 0=Specifies that end-to-end CRC check is not supported.
6	EcrcGenEn: end-to-end CRC enable. Read-only. 0=Specifies that End-to-end CRC generation is not supported.

5	EcreGenCap: end-to-end CRC capability. Read-only. 0=Specifies that end-to-end CRC generation is not supported.
4:0	FirstErrPtr: first error pointer. Read-only. The First Error Pointer identifies the bit position of the first error reported in the Uncorrectable Error Status register.

D2F[5:1]x16C Header Log DW0

Cold reset: 0000_0000h.

Bits	Description
31:0	TlpHdr: transaction layer packet header log. Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 0 of the header.

D2F[5:1]x170 Header Log DW1

Cold reset: 0000_0000h.

Bits	Description
31:0	TlpHdr: transaction layer packet header log. Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 4 of the header.

D2F[5:1]x174 Header Log DW2

Cold reset: 0000_0000h.

Bits	Description
31:0	TlpHdr: transaction layer packet header log. Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 8 of the header.

D2F[5:1]x178 Header Log DW3

Cold reset: 0000_0000h.

Bits	Description
31:0	TlpHdr: transaction layer packet header log. Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 12 of the header.

D2F[5:1]x17C Root Error Command

Reset: 0000_0000h.

Bits	Description
31:3	Reserved.
2	FatalErrRepEn: fatal error reporting enable. Read-write. 1=Enables the generation of an interrupt when a fatal error is reported by any of the devices in the hierarchy associated with this Root Port.

1	NonfatalErrRepEn: non-fatal error reporting enable. Read-write. 1=Enables generation of an interrupt when a non-fatal error is reported by any of the devices in the hierarchy associated with this Root Port.
0	CorrErrRepEn: correctable error reporting enable. Read-write. 1=Enables generation of an interrupt when a correctable error is reported by any of the devices in the hierarchy associated with this Root Port.

D2F[5:1]x180 Root Error Status

Cold reset: 0000_0000h.

Bits	Description
31:27	AdvErrIntMsgNum: advanced error interrupt message number. Read-only.
26:7	Reserved.
6	NFatalErrMsgRcvd: fatal error message received. Read; Write-1-to-clear. Set to 1 when one or more fatal uncorrectable error messages have been received.
5	NonFatalErrMsgRcvd: non-fatal error message received. Read; Write-1-to-clear. Set to 1 when one or more non-fatal uncorrectable error messages have been received.
4	FirstUncorrFatalRcvd: first uncorrectable fatal error message received. Read; Write-1-to-clear. Set to 1 when the first uncorrectable error message received is for a fatal error.
3	MultErrFatalNonfatalRcvd: ERR_FATAL/NONFATAL message received. Read; Write-1-to-clear. Set when either a fatal or a non-fatal error is received and ErrFatalNonfatalRcvd is already set.
2	ErrFatalNonfatalRcvd: ERR_FATAL/NONFATAL message received. Read; Write-1-to-clear. Set when either a fatal or a non-fatal error is received and this bit is not already set.
1	MultErrCorrRcvd: multiple ERR_COR messages received. Read; Write-1-to-clear. Set when a correctable error message is received and ErrCorrRcvd is already set.
0	ErrCorrRcvd: ERR_COR message received. Read; Write-1-to-clear. Set when a correctable error message is received and this bit is not already set.

D2F[5:1]x184 Error Source ID

Cold reset: 0000_0000h.

Bits	Description
31:16	ErrFatalNonfatalSrcID: ERR_FATAL/ERR_NONFATAL source identification. Read-only. Loaded with the requestor ID indicated in the received ERR_FATAL or ERR_NONFATAL message when D2F[5:1]x180[ErrFatalNonfatalRcvd] is not already set.
15:0	ErrCorrSrcID: ERR_COR source identification. Read-only. Loaded with the requestor ID indicated in the received ERR_COR message when D2F[5:1]x180[ErrCorrRcvd] is not already set.

3.9 Device 18h Function 0 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1580h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F0x04 Status/Command

Bits	Description
31:16	Status. Read-only. Value: 0010h. Bit[20] is set to indicate the existence of a PCI-defined capability block.
15:0	Command. Read-only. Value: 0000h.

D18F0x08 Class Code/Revision ID

Bits	Description
31:8	ClassCode. Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only. Value: 00h.

D18F0x0C Header Type

Read-only. Value: 0080_0000h.

Bits	Description
31:0	HeaderTypeReg. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device.

D18F0x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Value: 00h.

D18F0x[5C:40] Routing Table

Reset: 0004_0201h.

Table 112: Register Mapping for D18F0x[5C:40]

Register	Function
D18F0x40	Node 0
D18F0x[5C:44]	Reserved

Bits	Description
31:0	Reserved.

D18F0x60 Node ID

Bits	Description										
31:21	Reserved.										
20:16	CpuCnt[4:0]: CPU count bits[4:0]. Read-write. Reset: 0. Specifies the number of cores to be enabled (the boot core plus those cores enabled through D18F0x1DC[CpuEn]). <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>1 core</td></tr> <tr> <td>02h-01h</td><td><CpuCnt[4:0] + 1> cores</td></tr> <tr> <td>03h</td><td>4 cores</td></tr> <tr> <td>1Fh-04h</td><td>Reserved</td></tr> </table>	Bits	Description	00h	1 core	02h-01h	<CpuCnt[4:0] + 1> cores	03h	4 cores	1Fh-04h	Reserved
Bits	Description										
00h	1 core										
02h-01h	<CpuCnt[4:0] + 1> cores										
03h	4 cores										
1Fh-04h	Reserved										
15:0	Reserved.										

D18F0x64 Unit ID

Reset: 0000_00E0h.

Bits	Description
31:16	Reserved.
15:11	PspUnitId: PSP Unit ID. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the Unid ID used by the PSP. Only upstream requests that match this Unit ID will be allowed access to certain protected regions in DRAM.
10:8	Reserved.
7:6	HbUnit: host bridge Unit ID. Read-only. Specifies the coherent link Unit ID of the host bridge used by the coherent fabric.
5:4	MctUnit: memory controller Unit ID. Read-only. Specifies the coherent link Unit ID of the memory controller.
3:0	Reserved.

D18F0x68 Link Transaction Control

Bits	Description										
31	Reserved.										
30:28	Reserved.										
27:26	Reserved.										
25	Reserved.										
24	Reserved.										
23	InstallStateS . Read-write. Reset: 0. 1=Forces the default read block (RdBlk) install state to be shared instead of exclusive.										
22:21	DsNpReqLmt: downstream non-posted request limit . Read-write. Reset: 00b. BIOS: 10b. This specifies the maximum number of downstream non-posted requests issued by core(s) which may be outstanding on the IO links attached to this node at one time. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No limit</td></tr> <tr> <td>01b</td><td>limited to 1</td></tr> <tr> <td>10b</td><td>limited to 4</td></tr> <tr> <td>11b</td><td>limited to 8</td></tr> </table>	Bits	Description	00b	No limit	01b	limited to 1	10b	limited to 4	11b	limited to 8
Bits	Description										
00b	No limit										
01b	limited to 1										
10b	limited to 4										
11b	limited to 8										
20	SeqIdSrcNodeEn: sequence ID source node enable . Read-write. Reset: 0. 1=The source node ID of requests is provided in the SeqID field of the corresponding downstream IO link request packets. This may be useful for debug applications, in order to match downstream packets with their originating node. For normal operation, this bit should be cleared. Correct ordering of requests between different nodes is not ensured when this bit is set. Semaphore sharing between differing nodes may not work properly in systems which are capable of processing IO requests with differing non-zero SeqIds out of request order.										
19	ApicExtSpur: APIC extended spurious vector enable . Read-write. Reset: 0. This enables the extended APIC spurious vector functionality; it affects APICF0[Vector]. 0=The lower 4 bits of the spurious vector are read-only 1111b. 1=The lower 4 bits of the spurious vector are writable.										
18	ApicExtId: APIC extended ID enable . Read-write. Reset: 0. Enables the extended APIC ID functionality. 0=APIC ID is 4 bits. 1=APIC ID is 8 bits.										
17	ApicExtBrdCst: APIC extended broadcast enable . Read-write. Reset: 0. Enables the extended APIC broadcast functionality. 0=APIC broadcast is 0Fh. 1=APIC broadcast is FFh. If ApicExtBrdCst=1 then software must assert ApicExtId.										
16	LintEn: local interrupt conversion enable . Read-write. Reset: 0. 1=Enables the conversion of broadcast ExtInt and NMI interrupt requests to LINT0 and LINT1 local interrupts, respectively, before delivering to the local APIC. This conversion only takes place if the local APIC is hardware enabled. LINT0 and LINT1 are controlled by APIC3[60:50]. 0=ExtInt/NMI interrupts delivered unchanged.										
15	LimitCldtCfg: limit coherent link configuration space range . Read-write. Reset: 0. BIOS: 1.										
14:13	Reserved.										

12	Reserved.
11	RespPassPW: response PassPW. Read-write. Reset: 0. BIOS: 1. 1=The PassPW bit in all downstream link responses is set, regardless of the originating request packet. This technically breaks the PCI ordering rules but it is not expected to be an issue in the downstream direction. Setting this bit improves the latency of upstream requests by allowing the downstream responses to pass posted writes. 0=The PassPW bit in downstream responses is based on the RespPassPW bit of the original request.
10	DisFillP: disable fill probe. Read-write. Reset: 0. Controls probes for core-generated fills. 0=Probes issued for cache fills. 1=Probes not issued for cache fills. BIOS: 0. BIOS may set if single core.
9	DisRmtPMemC: disable remote probe memory cancel. Read-write. Reset: 0. 1=Only probed caches on the same node as the target memory controller may generate MemCancel coherent link packets. MemCancels are used to attempt to save DRAM and/or link bandwidth associated with the transfer of stale DRAM data. 0=Probes hitting dirty blocks may generate MemCancel packets, regardless of the location of the probed cache.
8	DisPMemC: disable probe memory cancel. Read-write. Reset: 0. Controls generation of MemCancel coherent link packets. MemCancels are used to attempt to save DRAM and/or coherent link bandwidth associated with the transfer of stale DRAM data. 0=Probes hitting dirty blocks of the core cache may generate MemCancel packets. 1=Probes may not generate MemCancel packets.
7	CPURdRspPassPW: CPU read response PassPW. Read-write. Reset: 0. 1=Read responses to core-generated reads are allowed to pass posted writes. 0=core responses do not pass posted writes. This bit is not expected to be set. This bit may only be set during the boot process.
6	CPUReqPassPW: CPU request PassPW. Read-write. Reset: 0. 1=Core-generated requests are allowed to pass posted writes. 0=Core requests do not pass posted writes. This bit is not expected to be set. This bit may only be set during the boot process.
5	Reserved.
4	DisMTS: disable memory controller target start. Read-write. Reset: 0. BIOS: 1. 1=Disables use of TgtStart. TgtStart is used to improve scheduling of back-to-back ordered transactions by indicating when the first transaction is received and ordered at the memory controller.
3	DisWrDwP: disable write doubleword probes. Read-write. Reset: 0. BIOS: 1. 1=Disables generation of probes for core-generated, WrSized doubleword commands.
2	DisWrBP: disable write byte probes. Read-write. Reset: 0. BIOS: 1. 1=Disables generation of probes for core-generated, WrSized byte commands.
1	DisRdDwP: disable read doubleword probe. Read-write. Reset: 0. BIOS: 1. 1=Disables generation of probes for core-generated, RdSized doubleword commands.
0	DisRdBP: disable read byte probe. Read-write. Reset: 0. BIOS: 1. 1=Disables generation of probes for core-generated, RdSized byte commands.

D18F0x6C Link Initialization Control

Bits	Description
31	Reserved.

30	RlsLnkFullTokCntImm: release upstream full token count immediately. Read-write. Cold reset: 0b. BIOS: 1 after buffer counts have been programmed. 1=Apply buffer counts programmed in D18F0x[F0,D0,B0,90] and D18F0x[F4,D4,B4,94] immediately without requiring warm reset. Once this bit is set, additional changes to the buffer counts only take effect upon warm reset.
29	Reserved.
28	RlsIntFullTokCntImm: release internal full token count immediately. Read-write. Cold reset: 0b. BIOS: 1 after buffer counts have been programmed. 1=Apply buffer counts programmed in D18F3x6C , D18F3x70 , D18F3x74 , D18F3x78 , D18F3x7C , D18F3x140 , D18F3x144 , D18F3x1[54:48] , D18F3x17C , and D18F3x1A0 immediately without requiring warm reset. Once this bit is set, additional changes to the buffer counts only take effect upon warm reset.
27	ApplyIsocModeEnNow. Read-write. Cold reset: 0b. BIOS: 1 after RlsLnkFullTokCntImm and RlsIntFullTokCntImm have been set. 1=Apply the programmed value in D18F0x[E4,C4,A4,84] [Iso-cEn] immediately without requiring warm reset. This bit may only be set if RlsLnkFullTokCntImm and RlsIntFullTokCntImm are set and isochronous buffers have been allocated. IF (ApplyIsocModeEnNow) THEN (D18F3x1[54:48] [IsocPreqTok0] > 0).
26:24	Reserved.
23	Reserved.
22:21	Reserved.
20	Reserved.
19:16	Reserved.
15:12	Reserved.
11	Reserved.
10:9	BiosRstDet[2:1]: BIOS reset detect bits[2:1]. See: BiosRstDet[0].
8	Reserved.
7	Reserved.
6	InitDet: CPU initialization command detect. Read-write. Reset: 0. This bit may be used by software to distinguish between an INIT and a warm or cold reset by setting it to a 1 before an initialization event is generated. This bit is cleared by RESET_L but not by an INIT command.
5	BiosRstDet[0]: BIOS reset detect bit[0]. Read-write. Cold reset: 0. BiosRstDet[2:0] = {BiosRstDet[2:1], BiosRstDet[0]}. May be used to distinguish between a reset event generated by the BIOS versus a reset event generated for any other reason by setting one or more of the bits to a 1 before initiating a BIOS-generated reset event.
4	ColdRstDet: cold reset detect. Read-write. Cold reset: 0. This bit may be used to distinguish between a cold versus a warm reset event by setting the bit to a 1 before an initialization event is generated.
3:2	Reserved.

1	Reserved.
0	RouteTblDis: routing table disable. Read-write. Reset: 1. BIOS: 0.

D18F0x[E4,C4,A4,84] Link Control

Table 113: [Register Mapping](#) for D18F0x[E4,C4,A4,84]

Register	Function
D18F0x84	ONION Link
D18F0x[E4,C4,A4]	Reserved

This register is derived from the link control register defined in the link specification.

Bits	Description
31:16	Reserved.
15	Addr64BitEn: 64-bit address packet enable. Read-write. Cold reset: 0000b. 1=Requests to addresses greater than FF_FFFF_FFFFh are supported by this IO link. 0=Requests to addresses greater than FF_FFFF_FFFFh are master aborted as if the end of chain was reached. BIOS is required to ensure that the link-specification-defined “64 Bit Address Feature” bit in the device on the other side of the link is set prior to setting this bit. For coherent links, this bit is unused. D18F0x68[CHtExtAddrEn] is required to be set if this bit is set for any IO link. The link specification indicates that this bit is cleared by a warm reset; therefore this bit may be in a different state than an IO device on the other side of the link after a warm reset; care should be taken by BIOS to place devices on both sides of the link in the same state after a warm reset, before any packets to the high-order addresses enabled by this bit are generated.
14:13	Reserved.
12	IsocEn: isochronous flow-control mode enable. Read-write. Cold reset:0b. BIOS: 1 if the link is an ONION Link. This bit is set to place the link into isochronous flow-control mode (IFCM), as defined by the link specification. 1=IFCM. 0=Normal flow-control mode. See D18F0x6C[ApplyIsocModeEnNow] .
11:6	Reserved.
5	Reserved.
4	LinkFail: link failure. Read; set-by-hardware; write-1-to-clear. Cold reset: 0. This bit is set high by the hardware if a sync flood is received by the link. See 2.16.1.9.1 [Common Diagnosis Information] .
3:0	Reserved.

D18F0x[EC,CC,AC,8C] Link Feature Capability

This register is derived from the link feature capability register defined in the link specification. Unless otherwise specified: 0=The feature is not supported; 1=The feature is supported.

Table 114: Register Mapping for D18F0x[EC,CC,AC,8C]

Register	Function
D18F0x8C	ONION Link
D18F0x[EC,CC,AC]	Reserved

Bits	Description
31:6	Reserved.
5	UnitIdReOrderDis: UnitID reorder disable. Read-write. Reset: 0. 1=Upstream reordering for different UnitIDs is not supported; i.e., all upstream packets are ordered as if they have the same UnitID. 0=Reordering based on UnitID is supported.
4	Reserved. Reset: 1.
3:2	Reserved.
1	Reserved. Reset: 1.
0	Reserved. Reset: 1.

D18F0x[F0,D0,B0,90] Link Base Channel Buffer Count

Read-write; Reset-applied.

Table 115: Register Mapping for D18F0x[F0,D0,B0,90]

Register	Function
D18F0x90	ONION Link
D18F0x[F0,D0,B0]	Reserved

[D18F0x\[F0,D0,B0,90\]](#) and [D18F0x\[F4,D4,B4,94\]](#) specify the *hard-allocated* link flow-control buffer counts in each virtual channel available to the transmitter at the other end of the link; it also provides the *free buffers* that may be used by any of the virtual channels, as needed. Base channel buffers are specified in [D18F0x\[F0,D0,B0,90\]](#); isochronous buffer counts (if in IFCM) are specified in [D18F0x\[F4,D4,B4,94\]](#). For all fields that specify buffer counts in [D18F0x\[F0,D0,B0,90\]](#) and [D18F0x\[F4,D4,B4,94\]](#), if the link is ganged, then the number of buffers allocated is 2 times the value of the field; If the link is unganged, then the number of buffers allocated is the value of the field.

The cold or warm reset value is determined by whether the link initializes, whether the link is IO/coherent, whether the link is ganged/unganged, and whether the settings are locked by LockBc. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

The hard-allocated buffer counts are transmitted to the device at the other end of the link in buffer release messages after link initialization. The remaining buffers are held in the free list (specified by FreeData and FreeCmd) used to optimize buffer usage. When a transaction is received, if a free-list buffer is available, it is used for storage instead of one of the hard allocated buffers; as a result, a buffer release (for one of the hard allocated buffers used by the incoming request) can be immediately sent back to the device at the other end of the link without waiting for the transaction to be routed beyond the flow-control buffers.

Table 116: Link Buffer Definitions

Term	Definition
LpbSize	Link Packet Command Buffer size. LpbSize = 24.
LpbdSize	Link Packet Data Buffer size. LpbdSize = 16.
LcsSize	Link Command Scheduler size. LcsSize = 32.

Buffer allocation rules:

- The total number of command buffers allocated in the base and isochronous registers of a link cannot exceed **LpbSize**:
 - $(D18F0x[90][NpReqCmd] + D18F0x[90][PReq] + D18F0x[90][RspCmd] + D18F0x[90][ProbeCmd] + D18F0x[90][FreeCmd] + D18F0x[94][IsocNpReqCmd] + D18F0x[94][IsocPReq] + D18F0x[94][IsocRspCmd]) \leq LpbSize$.
- The total number of data buffers allocated in the base and isochronous registers of a link cannot exceed **LpbdSize**:
 - $(D18F0x[90][NpReqData] + D18F0x[90][RspData] + D18F0x[90][PReq] + D18F0x[90][FreeData] + D18F0x[94][IsocPReq] + D18F0x[94][IsocNpReqData] + D18F0x[94][IsocRspData]) \leq LpbdSize$.
- The total number of hard allocated command buffers cannot exceed **LcsSize**.
 - $(D18F0x[90][ProbeCmd] + D18F0x[90][RspCmd] + D18F0x[90][PReq] + D18F0x[90][NpReqCmd] + D18F0x[94][IsocRspCmd] + D18F0x[94][IsocPReq] + D18F0x[94][IsocNpReqCmd]) \leq LcsSize$.
- BIOS must set up non-zero counts (and adjust the base channel counts accordingly) prior to enabling **IFCM**.
- If an **IOMMU** is present in the system, **D18F0x[F4,D4,B4,94][IsocNpReqCmd]** must be non-zero for all enabled links.
- If an **IOMMU** is present in the system, **D18F0x[E4,C4,A4,84][IsocEn]** must be enabled for the ONION link.

Bits	Description
31	LockBc: lock buffer count register. Cold reset: 0. BIOS: 1. 1=The buffer count registers, D18F0x[F0,D0,B0,90] and D18F0x[F4,D4,B4,94] are locked such that warm resets do not place the registers back to their default value. Setting this bit does not prevent the buffer counts from being updated after a warm reset based on the value of the buffer counts before the warm reset. 0=Upon warm reset, the buffer count registers return to their default value after the link initializes regardless of the value before the warm reset.
30	PReq[3]: posted request command and data buffer count [3]. IF (LockBc) THEN Cold reset: 0. ELSE Reset: 0. ENDIF. BIOS: 0. See: PReq[2:0].

29:28	NpReqData[3:2]: non-posted request data buffer count [3:2]. IF (LockBc) THEN Cold reset: 00b. ELSE THEN Reset: 00b. ENDIF. BIOS: IF (REG==D18F0x90) THEN 00b ELSE 11b ENDIF. See: NpReqData[1:0].
27:25	FreeData: free data buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: 0.
24:20	FreeCmd: free command buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: IF (REG==D18F0x90) THEN 00h ELSE 00h ENDIF.
19:18	RspData: response data buffer count. IF (LockBc) THEN Cold reset: 1. ELSE THEN Reset: 1. ENDIF. BIOS: IF (REG==D18F0x90) THEN 1 ELSE 0 ENDIF.
17:16	NpReqData[1:0]: non-posted request data buffer count [1:0]. NpReqData[3:0] = {NpReqData[3:2], NpReqData[1:0]}. IF (LockBc) THEN Cold reset: 01b. ELSE THEN Reset: 01b. ENDIF. BIOS: IF (REG==D18F0x90) THEN 01b ELSE 11b ENDIF.
15:12	ProbeCmd: probe command buffer count. IF (LockBc) THEN Cold reset: 0h. ELSE THEN Reset: 0h. ENDIF. BIOS: 0h.
11:8	RspCmd: response command buffer count. IF (LockBc) THEN Cold reset: 1h. ELSE THEN Reset: 1h. ENDIF. BIOS: IF (REG==D18F0x90) THEN 1h ELSE 0h ENDIF.
7:5	PReq[2:0]: posted request command and data buffer count [2:0]. PReq[3:0] = {PReq[3], PReq[2:0]}. Specifies the number of posted command and posted data buffers allocated. IF (LockBc) THEN Cold reset: 110b. ELSE Reset: 110b. ENDIF. BIOS: 101b.
4:0	NpReqCmd: non-posted request command buffer count. IF (LockBc) THEN Cold reset: 09h. ELSE THEN Reset: 09h. ENDIF. BIOS: IF (REG==D18F0x90) THEN 05h ELSE 18h ENDIF.

D18F0x[F4,D4,B4,94] Link Isochronous Channel Buffer Count

Read-write; Reset-applied. See [D18F0x\[F0,D0,B0,90\]](#).

Table 117: [Register Mapping](#) for [D18F0x\[F4,D4,B4,94\]](#)

Register	Function
D18F0x94	ONION Link
D18F0x[F4,D4,B4]	Reserved

Bits	Description
31:29	Reserved.
28:27	IsocRspData: isochronous response data buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: 0.
26:25	IsocNpReqData: isochronous non-posted request data buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: IF (REG==D18F0x94) THEN 1 ELSE 0 ENDIF.
24:22	IsocRspCmd: isochronous response command buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: 0.
21:19	IsocPReq: isochronous posted request command and data buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. This specifies the number of isochronous posted command and posted data buffers allocated. BIOS: 0.
18:16	IsocNpReqCmd: isochronous non-posted request command buffer count. IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: IF (REG==D18F0x94) THEN 1 ELSE 0 ENDIF.
15:8	SecBusNum: secondary bus number. Reset: 0. Specifies the configuration-space bus number of the IO link. When configured as a coherent link, this register has no meaning. This field should match the corresponding D18F1x[1DC:1D0,EC:E0][BusNumBase], unless D18F1x[1DC:1D0,EC:E0][DevCmpEn]=1, in which case this field should be 00h).
7:0	Reserved.

D18F0x[F8,D8,B8,98] Link Type

Table 118: Register Mapping for D18F0x[F8,D8,B8,98]

Register	Function
D18F0x98	ONION Link
D18F0x[F8,D8,B8]	Reserved

Bits	Description
31:6	Reserved.
5	PciEligible. Read-only. Reset: 1.
4:3	Reserved.
2	Reserved.
1	Reserved.
0	Reserved.

D18F0x[11C,118,114,110] Link Clumping Enable

Reset: 0000_0002h. D18F0x[11C,118,114,110] are associated with the whole link if it is ganged or sublink 0 if

it is ungang; If the node does not support a link, then the corresponding register addresses become reserved.

Table 119: [Register Mapping](#) for D18F0x[11C,118,114,110]

Register	Function
D18F0x110	ONION Link
D18F0x11[C:4]	Reserved

These registers specify how UnitIDs of upstream non-posted requests may be clumped per the link specification. The processor does not clump requests that it generates in the downstream direction.

Bits	Description
31:1	ClumpEn. Read-write. Each bit of this register corresponds to a link UnitID number. E.g., bit 2 corresponds to UnitID 02h, etc. 1=The specified UnitID is ordered in the same group as the specified UnitID - 1. For example, if this register is programmed to 0000_00C0h, then UnitIDs 7h, 6h, and 5h are all ordered as if they are part of the same UnitID. This is used to allow more than 32 tags to be assigned to a single stream for the purposes of ordering.
0	Reserved.

D18F0x150 Link Global Retry Control

Cold reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D18F0x168 Extended Link Transaction Control

Read-write.

Bits	Description
31:21	Reserved.
20	XcsSecPickerDstNcHt. Reset: 0. BIOS: 1.
19	Reserved.
18	Reserved.
17:15	Reserved.
14:12	Reserved.
11:0	Reserved.

D18F0x16C Link Global Extended Control

Reset: 0000_0000h.

Bits	Description
31:0	Reserved.

D18F0x[18C:170] Link Extended Control

These registers provide control for each link. They are mapped to the links as follows:

Table 120: [Register Mapping](#) for D18F0x[18C:170]

Register	Function
D18F0x170	ONION Link
D18F0x1[8C:74]	Reserved

Reset: 0000_0001h.

Bits	Description
31:0	Reserved.

D18F0x1A0 Link Initialization Status

Table 121: **Onion Definitions**

Term	Definition
OnionPlus	OnionPlus link detected. OnionPlus = (D18F0x1A0[OnionPlusCap]).

Bits	Description								
31	InitStatusValid: initialization status valid. Read-only; Updated-by-hardware. Reset: 0. 1=Indicates that the rest of the information in this register is valid for all links; each link is either not connected or the initialization is complete.								
30:28	Reserved.								
27:24	OnionPlusCap. Read-only; Updated-by-hardware. Reset: 0h. 1=OnionPlus capable link detected. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Link 0</td></tr> <tr> <td>[1]</td><td>Link 1</td></tr> <tr> <td>[2:3]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	Link 0	[1]	Link 1	[2:3]	Reserved
Bit	Description								
[0]	Link 0								
[1]	Link 1								
[2:3]	Reserved								
23:4	Reserved.								
3:2	InitComplete1: initialization complete for link 1. See: InitComplete0.								
1:0	InitComplete0: initialization complete for link 0. Read-only; Updated-by-hardware. Reset: 00b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Internal northbridge link has not completed initialization.</td></tr> <tr> <td>10b-01b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Internal northbridge link has completed initialization.</td></tr> </table>	Bits	Description	00b	Internal northbridge link has not completed initialization.	10b-01b	Reserved	11b	Internal northbridge link has completed initialization.
Bits	Description								
00b	Internal northbridge link has not completed initialization.								
10b-01b	Reserved								
11b	Internal northbridge link has completed initialization.								

D18F0x1DC Core Enable

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.

15:1	<p>CpuEn: core enable. Read-write. This field is used to enable each of the cores after a reset. 1=Enable the core to start fetching and executing code from the boot vector. The most significant bit N is indicated by CpuCoreNum, as defined in section 2.4.4 [Processor Cores and Downcoring]. All bits greater than N are reserved.</p> <table><tr><th><u>Bit</u></th><th><u>Description</u></th></tr><tr><td>[0]</td><td>Core 1 enable</td></tr><tr><td>[1]</td><td>Core <BIT+1> enable</td></tr><tr><td>[2]</td><td>Core 3 enable</td></tr><tr><td>[15:3]</td><td>Reserved</td></tr></table>	<u>Bit</u>	<u>Description</u>	[0]	Core 1 enable	[1]	Core <BIT+1> enable	[2]	Core 3 enable	[15:3]	Reserved
<u>Bit</u>	<u>Description</u>										
[0]	Core 1 enable										
[1]	Core <BIT+1> enable										
[2]	Core 3 enable										
[15:3]	Reserved										
0	Reserved.										

3.10 Device 18h Function 1 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F1x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1581h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F1x08 Class Code/Revision ID

Bits	Description
31:8	ClassCode. Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only. Value: 00h. Processor revision. 00h=A0.

D18F1x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:0	HeaderTypeReg. Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device.

D18F1x[17C:140,7C:40] DRAM Base/Limit

The following sets of registers specify the DRAM address ranges:

Table 122: Register Mapping for D18F1x[17C:140,7C:40]

Function	Base Low	Limit Low	Base High	Limit High
Range 0	D18F1x40	D18F1x44	Reserved	Reserved
Reserved	D18F1x48, D18F1x[7:5][8,0]	D18F1x4C, D18F1x[7:5][C,4]	D18F1x148, D18F1x1[7:5][8,0]	D18F1x14C, D18F1x1[7:5][C,4]

Transaction addresses that are within the specified base/limit range are routed to the DstNode. See 2.8.2 [NB Routing].

DRAM mapping rules:

F1x0XX registers provide the low address bits. F1x1XX registers are reserved.

- Transaction addresses are within the defined range if:
 $\{\text{DramBase}[39:24], 00_0000h\} \leq \text{address}[39:0] \leq \{\text{DramLimit}[39:24], FF_FFFFh\}$.
- DRAM regions must not overlap each other.
- Accesses to addresses that map to both DRAM, as specified by the DRAM base and limit registers (F1x[1, 0][7C:40]), and MMIO, as specified by D18F1x[2CC:2A0,1CC:180,BC:80], are routed to MMIO only.

- Programming of the DRAM address maps must be consistent with the Memory-Type Range Registers (MTRRs) and the top of memory registers, [MSRC001_001A](#) and [MSRC001_001D](#). CPU accesses only hit within the DRAM address maps if the corresponding MTRR is of type DRAM. Accesses from IO links are routed based on the DRAM base and limit registers (F1x[1, 0][7C:40]) only.
- The appropriate RE or WE bit(s) must be set. When initializing a base/limit pair, the BIOS must write the [limit] register before either the RE or WE bit is set. When changing a base/limit pair that is already enabled, the BIOS should clear RE and WE before changing the address range.
- See [2.8.2.1.1 \[DRAM and MMIO Memory Space\]](#).

When memory hoisting is enabled in a node via [D18F1x2\[1,0\]\[8,0\]\[LgcyMmioHoleEn\]](#), the corresponding BaseAddr/LimitAddr should be configured to account for the memory hoisted above the hole. See [2.9.10 \[Memory Hoisting\]](#).

D18F1x[7:4][8,0] DRAM Base Low

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000_0000h.

Table 123: [Register Mapping](#) for [D18F1x\[7:4\]\[8,0\]](#)

Register	Function
D18F1x40	Range 0
D18F1x48	Reserved
D18F1x[7:5][8,0]	Reserved

Bits	Description
31:16	DramBase[39:24]: DRAM base address register bits[39:24].
15:2	Reserved.
1	WE: write enable. 1=Writes to this address range are enabled.
0	RE: read enable. 1=Reads to this address range are enabled.

D18F1x[7:4][C,4] DRAM Limit Low

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF.

Table 124: [Register Mapping](#) for [D18F1x\[7:4\]\[C,4\]](#)

Register	Function
D18F1x44	Range 0
D18F1x4C	Reserved
D18F1x[7:5][C,4]	Reserved

Bits	Description
31:16	DramLimit[39:24]: DRAM limit address register bits[39:24]. Reset: FCFFh.
15:11	Reserved.

10:8	Reserved.
7:3	Reserved.
2:0	DstNode: destination Node ID. Reset: 000b. Specifies the node that a packet is routed to if it is within the address range.

D18F1x[2CC:2A0,1CC:180,BC:80] MMIO Base/Limit

These registers, The memory mapped IO base and limit registers [D18F1x\[2CC:2A0,1CC:180,BC:80\]](#) specify the mapping from memory addresses to the corresponding node and IO link for MMIO transactions. Address ranges are specified by upto 16 sets of base/limit registers.

Table 125: [Register Mapping](#) for [D18F1x\[2CC:2A0,1CC:180,BC:80\]](#)

Function	MMIO Base Low	MMIO Limit Low	MMIO Base/Limit High
Range 0	D18F1x80	D18F1x84	Reserved
Range 1	D18F1x88	D18F1x8C	Reserved
Range 2	D18F1x90	D18F1x94	Reserved
Range 3	D18F1x98	D18F1x9C	Reserved
Range 4	D18F1xA0	D18F1xA4	Reserved
Range 5	D18F1xA8	D18F1xAC	Reserved
Range 6	D18F1xB0	D18F1xB4	Reserved
Range 7	D18F1xB8	D18F1xBC	Reserved
Range 8	D18F1x1A0	D18F1x1A4	Reserved
Range 9	D18F1x1A8	D18F1x1AC	Reserved
Range 10	D18F1x1B0	D18F1x1B4	Reserved
Range 11	D18F1x1B8	D18F1x1BC	Reserved
Reserved	D18F1x2[B8,B0,A8, A0]	D18F1x2[BC,B4,AC,A4]	Reserved

Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See [2.8.2 \[NB Routing\]](#).

MMIO mapping rules:

- Transaction addresses are within the defined range if:
 $\{\text{MMIOBase}[39:16], 0000\text{h}\} \leq \text{address}[39:0] \leq \{\text{MMIOLimit}[39:16], \text{FFFFh}\}.$
- MMIO regions must not overlap each other.
- Accesses to addresses that map to both DRAM, as specified by the DRAM base and limit registers (see [D18F1x\[17C:140,7C:40\]](#)), and MMIO, as specified by the memory mapped IO base and limit registers ([F1x\[BC:80\]](#)), are routed to MMIO only.
- Programming of the MMIO address maps must be consistent with the Memory-Type Range Registers (MTRRs) and the top of memory registers, [MSRC001_001A](#) and [MSRC001_001D](#). CPU accesses only hit within the MMIO address maps if the corresponding MTRR is of type IO. Accesses from IO links are routed based on [D18F1x\[2CC:2A0,1CC:180,BC:80\]](#).
- The appropriate RE or WE bit(s) must be set. When initializing a base/limit pair, the BIOS must write the limit register before either the RE or WE bit is set. When changing a base/limit pair that is already enabled, the BIOS should clear RE and WE before changing the address range.
- Scenarios in which the address space of multiple MMIO ranges target the same IO device is supported.
- See [2.8.2.1.1 \[DRAM and MMIO Memory Space\]](#).

D18F1x[2B:1A,B:8][8,0] MMIO Base LowTable 126: [Register Mapping](#) for D18F1x[2B:1A,B:8][8,0]

Register	Function
D18F1x80	Range 0
D18F1x88	Range 1
D18F1x90	Range 2
D18F1x98	Range 3
D18F1xA0	Range 4
D18F1xA8	Range 5
D18F1xB0	Range 6
D18F1xB8	Range 7
D18F1x1A0	Range 8
D18F1x1A8	Range 9
D18F1x1B0	Range 10
D18F1x1B8	Range 11
D18F1x2[B:A][8,0]	Reserved

Bits	Description
31:8	MMIOBase[39:16]: MMIO base address register bits[39:16]. Read-write. Reset: 0.
7:4	Reserved.
3	Lock. Read-write. Reset: 0. 1=the memory mapped IO base and limit registers (D18F1x[2CC:2A0,1CC:180,BC:80]) are read-only (including this bit). WE or RE in this register must be set in order for this to take effect.
2	Reserved.
1	WE: write enable. Read-write. Reset: 0. 1=Writes to this address range are enabled.
0	RE: read enable. Read-write. Reset: 0. 1=Reads to this address range are enabled.

D18F1x[2B:1A,B:8][C,4] MMIO Limit LowTable 127: [Register Mapping](#) for D18F1x[2B:1A,B:8][C,4]

Register	Function
D18F1x84	Range 0
D18F1x8C	Range 1
D18F1x94	Range 2
D18F1x9C	Range 3
D18F1xA4	Range 4
D18F1xAC	Range 5
D18F1xB4	Range 6

Table 127: Register Mapping for D18F1x[2B:1A,B:8][C,4]

D18F1xBC	Range 7
D18F1x1A4	Range 8
D18F1x1AC	Range 9
D18F1x1B4	Range 10
D18F1x1BC	Range 11
D18F1x2[BC,B4,AC,A4]	Reserved.

Bits	Description										
31:8	MMIOLimit[39:16]: MMIO limit address register bits[39:16]. Read-write. Reset: 0.										
7	<p>NP: non-posted. Read-write. Reset: 0. 1=CPU write requests to this MMIO range are passed through the non-posted channel. This may be used to force writes to be non-posted for MMIO regions which map to the legacy ISA/LPC bus, or in conjunction with D18F0x68[DsNpReqLmt] in order to allow downstream CPU requests to be counted and thereby limited to a specified number. This latter use of the NP bit may be used to avoid loop deadlock scenarios in systems that implement a region in an IO device that reflects downstream accesses back upstream. See the link summary of deadlock scenarios for more information. 0=CPU writes to this MMIO range use the posted channel. This bit does not affect requests that come from IO links (the virtual channel of the request is specified by the IO request).</p> <p>If two MMIO ranges target the same IO device and the NP bit is set differently in both ranges, unexpected transaction ordering effects are possible. In particular, using PCI- and IO-link-defined producer-consumer semantics, if a producer (e.g., the processor) writes data using a non-posted MMIO range followed by a flag to a posted MMIO range, then it is possible for the device to see the flag updated before the data is updated.</p>										
6	DstSubLink: destination sublink. Read-write. Reset: 0. When a link is unganged, this bit specifies the destination sublink of the link specified by the memory mapped IO base and limit registers F1x[BC:80][DstLink]. 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.										
5:4	<p>DstLink: destination link ID. Read-write. Reset: 0. For transactions within this MMIO range, this field specifies the destination IO link number of the destination node.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table>	Bits	Description	00b	Link 0	01b	Link 1	10b	Link 2	11b	Link 3
Bits	Description										
00b	Link 0										
01b	Link 1										
10b	Link 2										
11b	Link 3										
3	Reserved.										
2:0	DstNode: destination node ID bits. Read-write. Reset: 0. For transactions within this MMIO range, this field specifies the destination node ID.										

D18F1x[DC:C0] IO-Space Base/Limit

The IO-space base and limit registers, [D18F1x\[DC:C0\]](#), specify the mapping from IO addresses to the corresponding node and IO link for transactions resulting from x86-defined IN and OUT instructions. IO address ranges are specified by upto 8 sets of base/limit registers. The first set is F1xC0 and F1xC4, the second

set is F1xC8 and F1xCC, and so forth. Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See 2.8.2 [NB Routing].

IO mapping rules:

- IO-space transaction addresses are within the defined range if:
{IOBase[24:12], 000h} <= address <= {IOLimit[24:12], FFFh} and as specified by the IE bit; or
if the address is in the range specified by the VE bits.
- IO regions must not overlap each other.
- The appropriate RE or WE bit(s) must be set.
- See 2.8.2.1.2 [IO Space].

D18F1x[1F:1E,D:C][8,0] IO-Space Base

Table 128: Register Mapping for D18F1x[1F:1E,D:C][8,0]

Register	Function
D18F1xC0	Range 0
D18F1xC8	Range 1
D18F1xD0	Range 2
D18F1xD8	Range 3
D18F1x1[F:E][8,0]	Reserved

Bits	Description
31:25	Reserved.
24:12	IOBase[24:12]: IO base address register bits[24:12]. Read-write. Reset: 0.
11:6	Reserved.
5	IE: ISA enable. Read-write. Reset: 0. 1=The IO-space address window is limited to the first 256 B of each 1 KB block specified; this only applies to the first 64 KB of IO space. 0=The PCI IO window is not limited in this way.
4	VE: VGA enable. Read-write. Reset: 0. 1=Include IO-space transactions targeting the VGA-compatible address space within the IO-space window of this base/limit pair. These include IO accesses in which address bits[9:0] range from 3B0h to 3BBh or 3C0h to 3DFh (address bits[15:10] are not decoded); this only applies to the first 64 KB of IO space; i.e., address bits[24:16] must be low). 0=IO-space transactions targeting VGA-compatible address ranges are not added to the IO-space window. This bit should only ever be set in one register. The MMIO range associated with the VGA enable bit in the PCI specification is NOT included in the VE bit definition; to map this range to an IO link, see D18F1xF4 [VGA Enable]. When D18F1xF4[VE] is set, the state of this bit is ignored.
3:2	Reserved.
1	WE: write enable. Read-write. Reset: 0. 1=Writes to this IO-space address range are enabled.
0	RE: read enable. Read-write. Reset: 0. 1=Reads to this IO-space address range are enabled.

D18F1x[1F:1E,D:C][C,4] IO-Space Limit

Table 129: Register Mapping for D18F1x[1F:1E,D:C][C,4]

Register	Function
D18F1xC4	Range 0
D18F1xCC	Range 1
D18F1xD4	Range 2
D18F1xDC	Range 3
D18F1x1[F:E][C,4]	Reserved

Bits	Description										
31:25	Reserved.										
24:12	IOLimit[24:12]: IO limit address register bits[24:12]. Read-write. Reset: 0.										
11:7	Reserved.										
6	DstSubLink: destination sublink. Read-write. Reset: 0. When a link is unganged, this bit specifies the destination sublink of the link specified by F1x[DC:C0][DstLink]. 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.										
5:4	DstLink: destination link ID. Read-write. Reset: 0. For transactions within this IO-space range, this field specifies the destination IO link number of the destination node. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table>	Bits	Description	00b	Link 0	01b	Link 1	10b	Link 2	11b	Link 3
Bits	Description										
00b	Link 0										
01b	Link 1										
10b	Link 2										
11b	Link 3										
3	Reserved.										
2:0	DstNode: destination node ID bits. Read-write. Reset: 0. For transactions within this IO-space range, this field specifies the destination node ID.										

D18F1x[1DC:1D0,EC:E0] Configuration Map

D18F1x[1DC:1D0,EC:E0] specify the mapping from configuration address to the corresponding node and IO link. Configuration address ranges are specified by upto 8 pairs of base/limit registers. Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See 2.8.2 [NB Routing].

Table 130: Register Mapping for D18F1x[1DC:1D0,EC:E0]

Register	Function
D18F1xE0	Range 0
D18F1xE4	Range 1
D18F1xE8	Range 2
D18F1xEC	Range 3
D18F1x1[DC:D0]	Reserved

Configuration space mapping rules:

- Configuration addresses (to “BusNo” and “Device” as specified by [IOCF8 \[IO-Space Configuration\]](#)

[Address](#)] in the case of IO accesses or [2.7 \[Configuration Space\]](#) in the case of MMIO accesses) are within the defined range if:

({BusNumBase[7:0]} <= BusNo <= {BusNumLimit[7:0]}) & (DevCmpEn==0); or
 ({BusNumBase[4:0]} <= Device <= {BusNumLimit[4:0]}) & (DevCmpEn==1) & (BusNo == 00h).

- Configuration regions must not overlap each other.
- The appropriate RE or WE bit(s) must be set.
- See [2.8.2.1.3 \[Configuration Space\]](#).

Bits	Description
31:24	BusNumLimit[7:0]: bus number limit bits[7:0] . Read-write. Reset: 0.
23:16	BusNumBase[7:0]: bus number base bits[7:0] . Read-write. Reset: 0.
15:3	Reserved.
2	DevCmpEn: device number compare mode enable . Read-write. Reset: 0. 1=A device number range rather than a bus number range is used to specify the configuration-space window (see above).
1	WE: write enable . Read-write. Reset: 0. 1=Writes to this configuration-space address range are enabled.
0	RE: read enable . Read-write. Reset: 0. 1=Reads to this configuration-space address range are enabled.

D18F1xF0 DRAM Hole Address

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Same-for-all. Reset: 0000_0000h. See [2.9.10 \[Memory Hoisting\]](#).

Bits	Description
31:24	DramHoleBase[31:24]: DRAM hole base address . Specifies the base address of the IO hole, below the 4GB address level, that is used in memory hoisting. Normally, DramHoleBase >= MSRC001_001A[TOM[31:24]] .
23:16	Reserved.
15:7	DramHoleOffset[31:23]: DRAM hole offset address . When D18F1x2[1,0][8,0][LgcyMmioHoleEn] ==1, this offset is subtracted from the physical address of certain accesses in forming the normalized address.
6:3	Reserved.
2	Reserved.
1	DramMemHoistValid: dram memory hoist valid . 1=Memory hoisting for the address range is enabled. 0=Memory hoisting is not enabled. This bit should be set if any D18F1x2[1,0][8,0][LgcyMmioHoleEn] ==1 or DramHoleBase != 0.
0	DramHoleValid: dram hole valid . 1=Memory hoisting is enabled in the node. 0=Memory hoisting is not enabled. This bit should be set in the node that owns the DRAM address space that is hoisted above the 4 GB address level. See DramHoleBase.

D18F1xF4 VGA Enable

Reset: 0000_0000h. All these bits are read-write unless Lock is set.

Bits	Description										
31:15	Reserved.										
14	DstSubLink: destination sublink. Read-write. When a link is unganged, this bit specifies the destination sublink of the link specified by D18F1xF4[DstLink] . 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.										
13:12	DstLink: destination link ID. Read-write. For transactions within the D18F1xF4[VE] -defined ranges, this field specifies the destination IO link number of the destination node. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table>	Bits	Description	00b	Link 0	01b	Link 1	10b	Link 2	11b	Link 3
Bits	Description										
00b	Link 0										
01b	Link 1										
10b	Link 2										
11b	Link 3										
11:7	Reserved.										
6:4	DstNode: destination node ID. Read-write. For transactions within the D18F1xF4[VE] -defined range, this field specifies the destination node ID.										
3	Lock. Read-write. 1=All the bits in this register (D18F1xF4) are read-only (including this bit).										
2	Reserved.										
1	NP: non-posted. Read-write. 1=CPU write requests to the D18F1xF4[VE] -defined MMIO range are passed through the non-posted channel. 0=CPU writes may be posted.										
0	VE: VGA enable. Read-write. 1=Transactions targeting the VGA-compatible address space are routed and controlled as specified by this register. The VGA-compatible address space is: (1) the MMIO range A_0000h through B_FFFFh; (2) IO-space accesses in which address bits[9:0] range from 3B0h to 3BBh or 3C0h to 3DFh (address bits[15:10] are not decoded; this only applies to the first 64 KB of IO space; i.e., address bits[24:16] must be low). 0=Transactions targeting the VGA-compatible address space are not affected by the state of this register. When this bit is set, the state of D18F1xF4[VE] is ignored.										

D18F1x10C DCT Configuration Select

Reset: 0000_0000h.

Bits	Description										
31:6	Reserved.										
5:4	NbPsSel: NB P-state configuration select. Read-write. Specifies the set of DCT Pstate registers to which accesses are routed. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>NB P-state 0</td></tr> <tr> <td>01b</td><td>NB P-state 1</td></tr> <tr> <td>10b</td><td>NB P-state 2</td></tr> <tr> <td>11b</td><td>NB P-state 3</td></tr> </table> <p>The following registers must be programmed for each NB P-state enabled by D18F5x16[C:0][NbPstateEn]:</p> <ul style="list-style-type: none"> • D18F2x210_dct[0]_nbp[3:0][MaxRdLatency, DataTxFifoWrDly]. • D18F2x210_dct[0]_nbp[3:0][RdPtrInit]. 	Bits	Description	00b	NB P-state 0	01b	NB P-state 1	10b	NB P-state 2	11b	NB P-state 3
Bits	Description										
00b	NB P-state 0										
01b	NB P-state 1										
10b	NB P-state 2										
11b	NB P-state 3										

3	MemPsSel: Memory P-state configuration select. Read-write. Specifies the set of DCT controller registers to which accesses are routed. This register works independently of NbPsSel. 0=Memory P-state 0. 1=Memory P-state 1. See 2.5.7.1 [Memory P-states] and 2.9.3 [DCT Configuration Registers] . The following registers must be programmed for each memory P-state enabled by D18F5x16[C:0][MemPstate] : <ul style="list-style-type: none"> • D18F2x2E8_dct[0]_mp[1:0] • D18F2x2EC_dct[0]_mp[1:0] 						
2:0	DctCfgSel: DRAM controller configuration select. Read-write. Specifies DCT controller to which accesses are routed. See 2.9.3 [DCT Configuration Registers] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>DCT 0</td></tr> <tr> <td>111b-001b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	DCT 0	111b-001b	Reserved
Bits	Description						
000b	DCT 0						
111b-001b	Reserved						

D18F1x120 DRAM Base System Address

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0000_0000h.

[D18F1x120](#) and [D18F1x124](#) are required to specify the base and limit system address range of the DRAM connected to the local node.

DRAM accesses to the local node with physical address Addr[47:0] that are within the following range are directed to the DCTs:

{DramBaseAddr[47:27], 000_0000h} <= Addr[47:0] <= {DramLimitAddr[47:27], 7FF_FFFFh};

DRAM accesses to the local node that are outside of this range are master aborted.

The address of the DRAM transaction is normalized before passing it to the DCTs by subtracting DramBaseAddr.

This range is also used to specify the range of DRAM covered by the scrubber (see [D18F3x58](#) and [D18F3x5C](#)).

Bits	Description
31:21	Reserved.
20:0	DramBaseAddr[47:27].

D18F1x124 DRAM Limit System Address

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. See [D18F1x120 \[DRAM Base System Address\]](#).

Bits	Description
31:24	Reserved
23:21	Reserved.
20:0	DramLimitAddr[47:27]. Cold reset: 1F_FFFFh.

D18F1x2[1C:00] DRAM Controller Base/Limit

The DRAM controller base and limit registers define a DRAM controller address range and specify the mapping of physical DRAM addresses to a DCT as selected by DctSel or DctIntLvEn. The following base/limit register pairs specify the address ranges:

Table 131: Register Mapping for D18F1x2[1C:00]

Function	Base Address	Limit Address
Range 0	D18F1x200	D18F1x204
Reserved	D18F1x208, D18F1x21[8,0]	D18F1x20C, D18F1x21[C,4]

BIOS should observe the following DCT configuration requirements:

- DRAM addresses are within the defined range if:
 $\{\text{DctBaseAddr}[39:27], 000b, 00_0000h\} \leq \text{address}[39:0] \leq \{\text{DctLimitAddr}[39:27], 111b, FF_FFFFh\}$.
- DCT base/limit address ranges must not overlap each other.
- A maximum of two address ranges may be mapped to a single DCT.

Hoisting. When memory hoisting is enabled via LegacyMmioHoleEn, the corresponding DctBaseAddr/DctLimitAddr should be configured to account for the memory hoisted above the hole. A contiguous memory hole should only be mapped by one DctBaseAddr/DctLimitAddr pair. See 2.9.10 [Memory Hoisting].

D18F1x2[1,0][8,0] DRAM Controller Base

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000_0000h.

Table 132: Register Mapping for D18F1x2[1,0][8,0]

Register	Function
D18F1x200	Range 0
D18F1x208	Reserved
D18F1x21[8,0]	Reserved

Bits	Description						
31:24	Reserved.						
23:11	DctBaseAddr[39:27]: DRAM controller base address [39:27]. Read-write. Specifies the base physical address bits for this address range.						
10:7	Reserved.						
6:4	DctSel: DRAM controller select. Read-write. Specifies the DCT mapped to this address range. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>DCT 0</td></tr> <tr> <td>111b-010b</td><td>Reserved</td></tr> </table>	Bits	Definition	000b	DCT 0	111b-010b	Reserved
Bits	Definition						
000b	DCT 0						
111b-010b	Reserved						
3	Reserved.						
2	Reserved.						

1	LgcyMmioHoleEn: legacy mmio hole enable. Read-write. BIOS: See 2.9.10 [Memory Hoisting] . 1=Enable memory hoisting for this address range. BIOS sets this bit for an address range that spans the 4GB boundary and contains a hole for addresses used by MMIO. 0=Memory hoisting is not enabled.
0	DctAddrVal: DRAM controller address valid. Read-write. 1=Specifies this address range is valid and enabled. 0=This address range is not enabled.

D18F1x2[1,0][C,4] DRAM Controller Limit

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000_0000h.

Table 133: [Register Mapping](#) for D18F1x2[1,0][C,4]

Register	Function
D18F1x204	Range 0
D18F1x20C	Reserved
D18F1x21[C,4]	Reserved

Bits	Description
31:24	Reserved.
23:11	DctLimitAddr[39:27]: DRAM controller limit address bits [39:27]. Read-write. Specifies the limit physical address bits for this address range.
10:4	Reserved.
3:0	Reserved.

3.11 Device 18h Function 2 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F2x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1582h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F2x08 Class Code/Revision ID

Reset: 0600_0000h.

Bits	Description
31:8	ClassCode. Read-only. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only.

D18F2x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:0	HeaderTypeReg. Read-only. These bits are fixed at their default values. The header type field indicates that there multiple functions present in this device.

D18F2x[5C:40]_dct[0] DRAM CS Base Address

See 2.9.3 [DCT Configuration Registers].

These registers along with [D18F2x\[6C:60\]_dct\[0\] \[DRAM CS Mask\]](#), translate DRAM request addresses (to a DRAM controller) into DRAM chip selects. Supported DIMM sizes are specified in [D18F2x80_dct\[0\] \[DRAM Bank Address Mapping\]](#). For more information on the DRAM controllers, see 2.9 [DRAM Controllers (DCTs)].

For each chip select, there is a DRAM CS Base Address register. For each CS pair there is a DRAM CS Mask Register. For each CS pair, an even CS must be populated if the odd CS is populated. If a chipselect is populated in the system it must be indicated to the DCT by setting one of the mutually exclusive {CSEnable, TestFail} configuration bits.

Table 134: DIMM, Chip Select, and Register Mapping

Base Address Registers	Mask Register	Logical DIMM	Chip Select ¹
D18F2x40_dct[x]	F2x60	0	MEMCS[x]_L[0]
D18F2x44_dct[x]			MEMCS[x]_L[1]

Table 134: DIMM, Chip Select, and Register Mapping

Base Address Registers	Mask Register	Logical DIMM	Chip Select ¹
D18F2x48_dct[x]	F2x64	1	MEMCS[x]_L[2]
D18F2x4C_dct[x]			MEMCS[x]_L[3]
D18F2x[5C:50]_dct[x]	F2x6[C,8]	Reserved	
1. See 2.9.4 [DDR Pad to Processor Pin Mapping]			

The DRAM controller operates on the normalized physical address of the DRAM request. The normalized physical address includes all of the address bits that are supported by a DRAM controller. See 2.8 [Northbridge (NB)].

Each base address register specifies the starting normalized address of the block of memory associated with the chip select. Each mask register specifies the additional address bits that are consumed by the block of memory associated with the chip selects. If both chip selects of a DIMM are used, they must be the same size; in this case, a single mask register covers the address space consumed by both chip selects.

Lower-order address bits are provided in the base address and mask registers, as well. These allow memory to be interleaved between chip selects, such that contiguous physical addresses map to the same DRAM page of multiple chip selects. See 2.9.9.1 [Chip Select Interleaving]. The hardware supports the use of lower-order address bits to interleave chip selects if (1) the each chip select of the memory system spans the same amount of memory and (2) the number of chip selects of the memory system is a power of two.

BIOS is required to assign the largest DIMM chip-select range to the lowest normalized address of the DRAM controller. As addresses increase, the chip-select size is required to remain constant or decrease. This is necessary to keep DIMM chip-select banks on aligned address boundaries, regardless as to the amount of address space covered by each chip select.

For each normalized address for requests that enters a DRAM controller, a ChipSelect[i] is asserted if:

```
CSEnable[i] &
( { (InputAddr[38:27] & ~AddrMask[i][38:27]),
    (InputAddr[21:11] & ~AddrMask[i][21:11]) } ==
  { (BaseAddr[i][38:27] & ~AddrMask[i][38:27]),
    (BaseAddr[i][21:11] & ~AddrMask[i][21:11]) } );
```

Bits	Description
31	Reserved.
30:19	BaseAddr[38:27]: normalized physical base address bits [38:27]. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
18:16	Reserved.
15:5	BaseAddr[21:11]: normalized physical base address bits [21:11]. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
4	Reserved.

3	OnDimmMirror: on-DIMM mirroring (ODM) enabled. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Address and bank bits are swapped by hardware for MRS commands sent to this chip select. This mode accounts for routing on the DIMM. Hardware bit swapping does not occur for commands sent via D18F2x7C_dct[0][SendMrsCmd] when D18F2x7C_dct[0][EnDramInit] = 0. This bit is expected to be set for the odd numbered rank of unbuffered DDR3 DIMMs if SPD byte 63 indicates that address mapping is mirrored. The following bits are swapped when enabled: <ul style="list-style-type: none"> • BA0 and BA1. • A3 and A4. • A5 and A6. • A7 and A8.
2	TestFail: memory test failed. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Set by BIOS to indicate that a rank is present but has failed memory training or a memory consistency test, indicating that the memory is bad or unused.
1	Reserved.
0	CSEnable: chip select enable. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.

D18F2x[6C:60]_dct[0] DRAM CS Mask

See 2.9.3 [DCT Configuration Registers]. See D18F2x[5C:40]_dct[0].

Bits	Description
31	Reserved.
30:19	AddrMask[38:27]: normalized physical address mask bits [38:27]. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
18:16	Reserved.
15:5	AddrMask[21:11]: normalized physical address mask bits [21:11]. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
4	Reserved.
3:2	Reserved.
1:0	Reserved.

D18F2x78_dct[0] DRAM Control

See 2.9.3 [DCT Configuration Registers].

Bits	Description
31	Reserved.
30:18	Reserved.
17	AddrCmdTriEn: address command tristate enable. Read-write. Reset: 0. BIOS: See 2.9.7.7. 1=Tristate the address, command, and bank buses when a Deselect command is issued.

16	Reserved.
15	Reserved.
14:11	Reserved.
10:0	Reserved.

D18F2x7C_dct[0] DRAM Initialization

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.7.8 \[DRAM Device and Controller Initialization\]](#).

BIOS can directly control the DRAM initialization sequence using this register. To do so, BIOS sets EnDramInit to start DRAM initialization. BIOS should then complete the initialization sequence specified in the appropriate JEDEC specification. After completing the sequence, BIOS clears EnDramInit to complete DRAM initialization. BIOS should not assert LDTSTOP_L while EnDramInit is set. Setting more than one of the command bits in this register (SendControlWord, SendMrsCmd, and SendAutoRefresh) at a time results in undefined behavior.

Bits	Description
31	EnDramInit: enable DRAM initialization. Read-write. 1=Place the DRAM controller in the BIOS-controlled DRAM initialization mode. The DCT deasserts CKE when this bit is set. BIOS must wait until D18F2x98_dct[0][DctAccessDone] = 1 before programming AssertCke=1 and DeassertMemRstX=1. BIOS must clear this bit after DRAM initialization is complete. BIOS must not set this bit on a DCT with no attached DIMMs.
30	Reserved.
29	SendZQCmd: send ZQ command. Read; write-1-only; cleared-by-hardware. 1=The DCT sends the ZQ calibration command with either all even or all odd chip selects active. The first command targets even chip selects. Subsequent commands alternate between even and odd chip selects. This bit is cleared by the hardware after the command completes. This bit is valid only when EnDramInit=1.
28	AssertCke: assert CKE. Read-write. Setting this bit causes the DCT to assert the CKE pins. This bit cannot be used to deassert the CKE pins.
27	DeassertMemRstX: deassert memory reset. Read-write. Setting this bit causes the DCT to deassert the memory reset. This bit cannot be used to assert the memory reset pin.
26	SendMrsCmd: send MRS command. Read; write-1-only; cleared-by-hardware. 1=The DCT sends the MRS commands defined by the MrsChipSel, MrsAddress, and MrsBank fields of this register. This bit is cleared by hardware after the command completes. Reserved if D18F2x78_dct[0][AddrCmdTriEn] =1.

25	SendAutoRefresh: send auto refresh command. Read; write-1-only; cleared-by-hardware. 1=The DCT sends an auto refresh command. This bit is cleared by hardware after the command completes.
24	Reserved.
23:21	MrsChipSel: MRS command chip select. Read-write. Specifies which DRAM chip select is used for MRS commands. Defined only if (\sim EnDramInit \sim D18F2x90_dct[0][UnbuffDimm]); otherwise MRS commands are sent to all chip selects. <div> <div>Bits</div> <div>Description</div> </div> 000b MRS command is sent to CS0 110b-001b MRS command is sent to CS<MrsChipSel> 111b MRS command is sent to CS7
20:18	MrsBank[2:0]: bank address for MRS commands. Read-write. Specifies the data driven on the DRAM bank pins for MRS commands.
17:0	MrsAddress[17:0]: address for MRS commands. Read-write. Specifies the data driven on the DRAM address pins for MRS commands.

D18F2x80_dct[0] DRAM Bank Address Mapping

IF (D18F2x118[LockDramCfg]) THEN Read-only, ELSE Read-write, ENDIF. Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. These fields specify DIMM configuration information. These fields are required to be programmed based on the DRAM device size and with information of the DIMM. Table 135 shows the bit numbers for each position.

Bits	Description
31:16	Reserved.
15:8	Reserved.
7:4	DimmAddrMap1: DIMM 1 address map.
3:0	DimmAddrMap0: DIMM 0 address map.

Table 135: DDR3 DRAM Address Mapping

Bits	CS Size	Device size, width	Bank			Address																
			2	1	0		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0000b		Reserved				Row																
						Col																
0001b	256MB	512Mb, x16	15	14	13	Row	x	x	x	x	17	16	27	26	25	24	23	22	21	20	19	18
						Col	x	x	x	x	x	AP	12	11	10	9	8	7	6	5	4	3
0010b	512MB	512Mb, x8 1Gb, x16	15	14	13	Row	x	x	x	17	16	28	27	26	25	24	23	22	21	20	19	18
						Col	x	x	x	x	x	AP	12	11	10	9	8	7	6	5	4	3
0011b		Reserved				Row																
						Col																
0100b		Reserved				Row																
						Col																
0101b	1GB	1Gb, x8 2Gb, x16	15	14	13	Row	x	x	17	16	29	28	27	26	25	24	23	22	21	20	19	18
						Col	x	x	x	x	x	AP	12	11	10	9	8	7	6	5	4	3
0110b		Reserved																				

Table 135: DDR3 DRAM Address Mapping

Bits	CS Size	Device size, width	Bank			Address																
			2	1	0		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0111b	2GB	2Gb, x8	15	14	13	Row	x	17	16	30	29	28	27	26	25	24	23	22	21	20	19	18
		4Gb, x16				Col	x	x	x	x	x	AP	12	11	10	9	8	7	6	5	4	3
1000b		Reserved																				
1001b		Reserved																				
1010b	4GB	4Gb, x8	15	14	13	Row	17	16	31	30	29	28	27	26	25	24	23	22	21	20	19	18
		8Gb, x16				Col	x	x	x	x	x	AP	12	11	10	9	8	7	6	5	4	3
1011b	8GB	8Gb, x8	16	15	14	Row	17	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18
						Col	x	x	x	x	13	AP	12	11	10	9	8	7	6	5	4	3
1111b- 1100b		Reserved																				

D18F2x84_dct[0] DRAM MRS

Reset: 0000_0005h. See 2.9.3 [DCT Configuration Registers].

Bits	Description																												
31:24	Reserved.																												
23	<p>PchgPDMoSel: precharge power down mode select. Read-write. BIOS: 1. Specifies how a chip select enters and exits power down mode. This mode is enabled by D18F2x94_dct[0][PowerDownEn] and its behavior varies based on the setting of D18F2x94_dct[0][PowerDownMode] and MR0[PPD] in D18F2x2E8_dct[0]_mp[1:0][MxMr0].</p> <table><tr><th>PowerDownMode</th><th>PchgPDMoSel</th><th>MR0[PPD]</th><th>Description</th></tr><tr><td>0b</td><td>0b</td><td>0b</td><td>Full channel slow exit (DLL off)</td></tr><tr><td>0b</td><td>0b</td><td>1b</td><td>Full channel fast exit (DLL on)</td></tr><tr><td>0b</td><td>1b</td><td>xb</td><td>Full channel dynamic fast exit/slow exit</td></tr><tr><td>1b</td><td>0b</td><td>0b</td><td>Reserved</td></tr><tr><td>1b</td><td>0b</td><td>1b</td><td>Partial channel fast exit (DLL on)</td></tr><tr><td>1b</td><td>1b</td><td>xb</td><td>Partial channel dynamic fast exit/slow exit</td></tr></table> <p>See D18F2x248_dct[0]_mp[1:0][Txpdll, Txp]. In dynamic fast exit/slow exit power down mode, the DCT dynamically issues MRS command(s) to the DRAM to specify the powerdown mode; the DCT specifies fast exit mode when chip selects on one of the CKEs has recently been active; it specifies deep power down when chip selects on all CKEs have been idle. PchgPDMoSel=0 && MR0[PPD]=1 fast exit modes are reserved if S3 is also supported .</p>	PowerDownMode	PchgPDMoSel	MR0[PPD]	Description	0b	0b	0b	Full channel slow exit (DLL off)	0b	0b	1b	Full channel fast exit (DLL on)	0b	1b	xb	Full channel dynamic fast exit/slow exit	1b	0b	0b	Reserved	1b	0b	1b	Partial channel fast exit (DLL on)	1b	1b	xb	Partial channel dynamic fast exit/slow exit
PowerDownMode	PchgPDMoSel	MR0[PPD]	Description																										
0b	0b	0b	Full channel slow exit (DLL off)																										
0b	0b	1b	Full channel fast exit (DLL on)																										
0b	1b	xb	Full channel dynamic fast exit/slow exit																										
1b	0b	0b	Reserved																										
1b	0b	1b	Partial channel fast exit (DLL on)																										
1b	1b	xb	Partial channel dynamic fast exit/slow exit																										

22:2	Reserved.								
1:0	<p>BurstCtrl: burst length control. Read-write. BIOS: 01b. Specifies the number of sequential beats of DQ related to one read or write command. Requests from the processor are always 64-byte-length. Requests generated by D18F2x250_dct[0] are always 64-byte-length. Requests from GMC may be 32-byte or 64-byte-length. Software must ensure that GMC requests are disabled to configure the DCT and DRAMs for 8-beat burst length (e.g. during training). If this mode is changed, software must issue a mode-register set command to MR0 of the DRAMs to place them in the same mode.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>8 beats</td></tr> <tr> <td>01b</td><td>Dynamic 4 or 8 beats</td></tr> <tr> <td>11b-10b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	8 beats	01b	Dynamic 4 or 8 beats	11b-10b	Reserved
Bits	Description								
00b	8 beats								
01b	Dynamic 4 or 8 beats								
11b-10b	Reserved								

D18F2x88_dct[0] DRAM Timing Low

Reset: 3F00_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description														
31:30	Reserved.														
29:24	<p>MemClkDis: MEMCLK disable. Read-write. 1=Disable the MEMCLK. 0=Enable MEMCLK. All enabled clocks should be 0; all no-connect and unused clocks should be 1.</p> <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMCLK_H[0]</td></tr> <tr> <td>[1]</td><td>MEMCLK_H[1]</td></tr> <tr> <td>[2]</td><td>MEMCLK_H[2]</td></tr> <tr> <td>[3]</td><td>MEMCLK_H[3]</td></tr> <tr> <td>[4]</td><td>MEMCLK_H[4]</td></tr> <tr> <td>[5]</td><td>MEMCLK_H[5]</td></tr> </table>	Bit	Pad	[0]	MEMCLK_H[0]	[1]	MEMCLK_H[1]	[2]	MEMCLK_H[2]	[3]	MEMCLK_H[3]	[4]	MEMCLK_H[4]	[5]	MEMCLK_H[5]
Bit	Pad														
[0]	MEMCLK_H[0]														
[1]	MEMCLK_H[1]														
[2]	MEMCLK_H[2]														
[3]	MEMCLK_H[3]														
[4]	MEMCLK_H[4]														
[5]	MEMCLK_H[5]														
23:0	Reserved.														

D18F2x8C_dct[0] DRAM Timing High

See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description										
31:19	Reserved.										
18	<p>DisAutoRefresh: disable automatic refresh. Read-write. Reset: 0. BIOS: See 2.9.7.7. 1=Automatic refresh is disabled.</p>										
17:16	<p>Tref: refresh rate. Read-write. Reset: 0. BIOS: See 2.9.7.5. This specifies the average time between refresh requests to all DRAM devices.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Undefined behavior.</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Every 7.8 us</td></tr> <tr> <td>11b</td><td>Every 3.9 us</td></tr> </table>	Bits	Description	00b	Undefined behavior.	01b	Reserved	10b	Every 7.8 us	11b	Every 3.9 us
Bits	Description										
00b	Undefined behavior.										
01b	Reserved										
10b	Every 7.8 us										
11b	Every 3.9 us										
15:0	Reserved.										

D18F2x90_dct[0] DRAM Configuration Low

See 2.9.3 [DCT Configuration Registers].

Bits	Description										
31:28	<p>IdleCycLimit: idle cycle limit. Read-write. Reset: 8h. BIOS: 8h. Specifies the number of MEMCLK cycles an idle page is open before it is closed if DynPageCloseEn=0. This field is ignored if DynPageCloseEn=1.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>8 clocks</td></tr> <tr> <td>Fh-1h</td><td><IdleCycLimit>*16 clocks</td></tr> </table>	Bits	Description	0h	8 clocks	Fh-1h	<IdleCycLimit>*16 clocks				
Bits	Description										
0h	8 clocks										
Fh-1h	<IdleCycLimit>*16 clocks										
27	<p>DisDllShutdownSR: disable DLL shutdown in self-refresh mode. Read-write. Reset: 1. BIOS: See 2.9.7.7.</p> <p>1=Disable the power saving features of shutting down DDR phy DLLs during DRAM self refresh and memory P-states. 0=Shutdown DLLs during DRAM self refresh and allow memory P-state transitions.</p>										
26	Reserved.										
25	<p>PendRefPaybackS3En: pending refresh payback S3 enable. Read-write. Reset: 0. BIOS: 1. Specifies the S3 refresh payback behavior when PendRefPayback=0. 1=Pending refreshes are paid back on S3 entry. 0=Pending refreshes are not paid back on S3 entry.</p>										
24	<p>StagRefEn: Stagger Refresh Enable. Read-write. Reset: 0. BIOS: 1. 1=The DRAM controller arbitrates refreshes among chip selects based on the Tstag value. See D18F2x228_dct[0]. 0=DCT arbitrates among chip selects using the Trfc value.</p>										
23	<p>ForceAutoPchg: force auto precharging. Read-write. Reset: 0. BIOS: See 2.9.7.7.</p> <p>1=Force auto-precharge cycles with every read or write command.</p>										
22:21	<p>IdleCycLowLimit: idle cycle low limit. Read-write. Reset: 0. Specifies the number of MEMCLK cycles a page is allowed to be open before it may be closed by the dynamic page close logic. This field is ignored if D18F2x90_dct[0][DynPageCloseEn] = 0.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>16 clocks</td></tr> <tr> <td>01b</td><td>32 clocks</td></tr> <tr> <td>10b</td><td>64 clocks</td></tr> <tr> <td>11b</td><td>96 clocks</td></tr> </table>	Bits	Description	00b	16 clocks	01b	32 clocks	10b	64 clocks	11b	96 clocks
Bits	Description										
00b	16 clocks										
01b	32 clocks										
10b	64 clocks										
11b	96 clocks										
20	<p>DynPageCloseEn: dynamic page close enable. Read-write. Reset: 0. See 2.9.7.7 [DCT Training Specific Configuration].</p> <p>1=The DRAM controller dynamically determines when to close open pages based on the history of that particular page and D18F2x90_dct[0][IdleCycLowLimit]. 0=Any open pages not auto-pre-charged by the DRAM controller are automatically closed after IdleCycLimit clocks of inactivity.</p>										
19	<p>DimmEccEn: DIMM ECC enable. Read-write. Reset: 0. 1=ECC checking is capable of being enabled for all DIMMs on the DRAM controller by D18F3x44[DramEccEn]. This bit should not be set unless all populated DIMMs support ECC check bits. 0=ECC checking is disabled on the DRAM controller.</p>										

18	PendRefPayback: pending refresh payback. Read-write. Reset: 0. BIOS: 0. 1=The DRAM controller executes all pending refresh commands before entering the self refresh state. 0=The controller enters the self refresh state regardless of the number of pending refreshes; applies to any self refresh entry if PendRefPaybackS3En=0, else any non-S3 self refresh entry.
17	EnterSelfRef: enter self refresh command. Read, write-1-only; cleared-by-hardware. Reset: 0. 1=The DRAM controller places the DRAMs into self refresh mode. The DRAM interface is tristated 1 MEMCLK after the self refresh command is issued to the DRAMs. Once entered, the DRAM interface must remain in self refresh mode for a minimum of 5 MEMCLKs. This bit is read as a 1 while the enter-self-refresh command is executing; it is read as 0 at all other times.
16	UnbuffDimm: unbuffered DIMM. Read-write or read-only, depending on the product. Reset: Product-specific. BIOS: 1. 1=The DRAM controller is connected to unbuffered DIMMs. 0=Reserved.
15:12	Reserved.
11	Reserved.
10	Reserved.
9	Reserved.
8	Reserved.
7	Reserved.
6	Reserved.
5	Reserved.
4	Reserved.
3	Reserved.
2	Reserved.
1	ExitSelfRef: exit self refresh (after suspend to RAM or for DRAM training) command. Read, write-1-only; cleared-by-hardware. Reset: 0. Writing a 1 to this bit causes the DRAM controller to bring the DRAMs out of self refresh mode. It also causes the DRAM controller to issue ZQCL and MRS MR0 commands. This command should be executed by BIOS when returning from the suspend to RAM state, after the DRAM controller configuration registers are properly initialized, or when self refresh is used during DRAM training. This bit is read as a 1 while the exit-self-refresh command is executing; it is read as 0 at all other times. This bit should not be set if the DCT is disabled.
0	Reserved.

D18F2x94_dct[0] DRAM Configuration High

See 2.9.3 [DCT Configuration Registers].

Bits	Description						
31	DphyMemPsSelEn: Ddr phy MemPsSel enable. Read-write. Reset: 1h. BIOS: 1. 1=The DCT uses D18F1x10C[MemPsSel] to select the memory P-state context of a phy register accessed by software with DctOffset[29:20] ==0D0h. DctOffset[6] is ignored. 0=Software accesses use DctOffset[6] to select context of those registers. If DctOffset[29:20] !=0D0h then this register has no effect. See D18F2x9C_x0D04_E008_dct[0][PStateToAccess] .						
30:29	Reserved.						
28:24	DcqBypassMax: DRAM controller queue bypass maximum. Read-write. Reset: 0h. BIOS: 2.9.7.7 . The DRAM controller arbiter normally allows transactions to pass other transactions in order to optimize DRAM bandwidth. This field specifies the maximum number of times that the oldest memory-access request in the DRAM controller queue may be bypassed before the arbiter decision is overridden and the oldest memory-access request is serviced instead. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No bypass; the oldest request is never bypassed.</td></tr> <tr> <td>1Fh-1h</td><td>The oldest request may be bypassed no more than <DcqBypassMax> time.</td></tr> </table>	Bits	Description	0h	No bypass; the oldest request is never bypassed.	1Fh-1h	The oldest request may be bypassed no more than <DcqBypassMax> time.
Bits	Description						
0h	No bypass; the oldest request is never bypassed.						
1Fh-1h	The oldest request may be bypassed no more than <DcqBypassMax> time.						
23	ProcOdtDis: processor on-die termination disable. Read-write. Reset: 0h. 1=The processor-side on-die termination is disabled. 0=Processor-side on-die termination enabled. Changes to this bit must be performed prior to setting MemClkFreqVal .						
22	BankSwizzleMode: bank swizzle mode. Read-write. Reset: 0. BIOS: 2.9.7.7 . 1=Remaps the DRAM device bank address bits as a function of normalized physical address bits. Each of the bank address bits, as specified in D18F2x80_dct[0] , are remapped as follows: <ul style="list-style-type: none"> Define X as a bank address bit (e.g., X=15 if the bank bit is specified to be address bit 15). Define S(n) as the state of address bit n (0 or 1) and B as the remapped bank address bit. Then, $B = S(X) \wedge S(X + 3) \wedge S(X + 6)$; for an 8-bank DRAM. For example, encoding 02h of Table 135 would be remapped from Bank[2:0]={A15, A14, A13} to the following: Bank[2:0] = {A15^A18^A21, A14^A17^A20, A13^A16^A19}.						
21	FreqChgInProg: frequency change in progress. Read-only. Reset: 0. 1=A MEMCLK frequency change is in progress. The DDR phy asserts this bit when it is in the process of locking the PLL. BIOS should not program the phy registers while this bit is set. 0=DRAM-interface commands can be sent to the phy.						
20	SlowAccessMode: slow access mode (a.k.a. 2T mode). Read-write. Reset: 0. 1=One additional MEMCLK of setup time is provided on all DRAM address and control signals (not including CS, CKE, and ODT); i.e., these signals are driven for two MEMCLK cycles rather than one. 0=DRAM address and control signals are driven for one MEMCLK cycle. 2T mode may be needed in order to meet electrical requirements of certain DIMM speed and loading configurations. If memory P-states are enabled then BIOS must set this bit if 2T timing is recommended for either memory P-state.						
19	Reserved. Reset: 1.						

18	Reserved.										
17	Reserved.										
16	<p>PowerDownMode: power down mode. Read-write. Reset: 0. BIOS: 1. Specifies how a chip select or group of chip selects enters power down mode when enabled by D18F2x94_dct[0][PowerDownEn]. A chip select enters power down mode when the DCT deasserts the CKE pin. The command and address signals tristate one MEMCLK after CKE deasserts. The DCT behavior varies based on the setting of D18F2x84_dct[0][PchgPDMoSel]. See also Table 134 [DIMM, Chip Select, and Register Mapping].</p> <p>0=Channel CKE control mode; the DRAM channel is placed in power down mode when all chip selects associated with the channel are idle; CKE pins for the channel operate in lock step in terms of placing the channel in power down mode.</p> <p>1=Chip select CKE control mode; the chip select group controlled by a CKE pin is placed in power down mode when all chip selects associated with the pin are idle.</p>										
15	<p>PowerDownEn: power down mode enable. Read-write. Reset: 0. BIOS: 1.</p> <p>1=Power down mode is enabled. Only precharge power down mode is supported, not active power down mode. See PowerDownMode, D18F2x84_dct[0][PchgPDMoSel], D18F2xA8_dct[0][PrtlChPDEnhEn], AggrPDEn, PDPhyPSDis, and D18F2x248_dct[0]_mp[1:0][PchgPDEnDelay].</p>										
14	<p>DisDramInterface: disable the DRAM interface. Read-write. Reset: 0. 1=The DRAM controller is disabled and the DRAM interface is placed into a low power state. This bit must be set if there are no DIMMs connected to the DCT.</p>										
13	Reserved.										
12	Reserved.										
11:10	<p>ZqcsInterval: ZQ calibration short interval. Read-write. Reset: 00b. BIOS: See 2.9.7.7. This field specifies the programmable interval for the controller to send out the DRAM ZQ calibration short command.</p> <table> <thead> <tr> <th>Bits</th><th>Description</th></tr> </thead> <tbody> <tr> <td>00b</td><td>ZQ calibration short command is disabled</td></tr> <tr> <td>01b</td><td>64 ms</td></tr> <tr> <td>10b</td><td>128 ms</td></tr> <tr> <td>11b</td><td>256 ms</td></tr> </tbody> </table>	Bits	Description	00b	ZQ calibration short command is disabled	01b	64 ms	10b	128 ms	11b	256 ms
Bits	Description										
00b	ZQ calibration short command is disabled										
01b	64 ms										
10b	128 ms										
11b	256 ms										
9:8	Reserved.										
7	<p>MemClkFreqVal: memory clock frequency valid. Read-write. Reset: 0. System BIOS should set this bit after setting up D18F2x94_dct[0][MemClkFreq] to the proper value. This indicates to the DRAM controller that it may start driving MEMCLK at the proper frequency. This bit should not be set if the DCT is disabled. BIOS must change each DCT's operating frequency in order. See 2.9.7.4.2 [DRAM Channel Frequency Change].</p>										

6:5	Reserved.
4:0	MemClkFreq: memory clock frequency. Read-write. Reset: 000b. Specifies the frequency and rate of the DRAM interface (MEMCLK). See: Table 136 [Valid Values for Memory Clock Frequency Value Definition] . The rate is twice the frequency. See D18F5x84[DdrMaxRate] and D18F5x84[DdrMaxRateEnf] . See MemClkFreqVal.

Table 136: [Valid Values](#) for Memory Clock Frequency Value Definition

Bits	Description
01h-00h	Reserved
02h	200 MHz. (400 MT/s)
03h	Reserved
04h	333 MHz. (667 MT/s)
05h	Reserved
06h	400 MHz. (800 MT/s)
09h-07h	Reserved
0Ah	533 MHz. (1066 MT/s)
0Dh-0Bh	Reserved
0Eh	667 MHz. (1333 MT/s)
11h-0Fh	Reserved
12h	800 MHz. (1600 MT/s)
15h-13h	Reserved
16h	933 MHz. (1866 MT/s)
1Fh-17h	Reserved
1Ah	1066 MHz. (2133 MT/s)
1Fh	Reserved

D18F2x98_dct[0] DRAM Controller Additional Data Offset

Reset: 8000_0000h. See 2.9.3 [DCT Configuration Registers].

Each DCT includes an array of registers that are used primarily to control DRAM-interface electrical parameters. Access to these registers is accomplished as follows:

Reads:

1. Write the register number to [D18F2x98_dct\[0\]\[DctOffset\]](#) with [D18F2x98_dct\[0\]\[DctAccessWrite\]](#)=0.
2. Read the register contents from [D18F2x9C_dct\[0\]](#).

Writes:

1. Write all 32 bits of register data to [D18F2x9C_dct\[0\]](#) (individual byte writes are not supported).
2. Write the register number to [D18F2x98_dct\[0\]\[DctOffset\]](#) with [D18F2x98_dct\[0\]\[DctAccessWrite\]](#)=1.
 - The data will be delivered to the phy similar to a posted memory-write, and the write will complete without any further action. However, to ensure that the contents of the array register write have been delivered to the phy, software issues a subsequent configuration register read or write to any register in the northbridge. For example, reading [D18F2x98_dct\[0\]](#) will accomplish this.

Registers for which there is one instance per memory P-state (listed with “_mp[1:0]” appended to the register mnemonic) use [D18F1x10C\[MemPsSel\]](#), [D18F2x94_dct\[0\]\[DphyMemPsSelEn\]](#), and [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#) for software accesses. BIOS programs these fields appropriately to ensure consistency of registers with controller fields and DDR phy fields.

- [D18F2x9C_x0000_0\[3:0\]0\[3:1\]_dct\[0\]_mp\[1:0\]](#) refers to all instances of the [D18F2x9C_x0000_0\[3:0\]0\[3:1\]](#) register.
- [D18F2x9C_x0000_0\[3:0\]0\[3:1\]_dct\[0\]_mp\[1\]](#) refers to the register for memory P-state 1 of either or both DCTs.
- It is recommended that BIOS program context sensitive registers in batches (training/restoring all registers of a context before selecting a new context). BIOS should do the following prior to a new “batch”:
 - Program [D18F2x94_dct\[0\]\[DphyMemPsSelEn\]](#)=1.
 - Program [D18F2x9C_x0D04_E008_dct\[0\]\[PStateToAccess\]](#)=target.
 - Program [D18F1x10C\[MemPsSel\]](#)=target.

Writes to any register in this additional address space causes the FIFO pointers to be reset. Therefore, it is recommended that only BIOS write these registers.

Reads or writes to any register in this additional address space collide with system self-refresh requests. Once power management is enabled software should temporarily disable power management prior to accessing these registers.

Bits	Description
31	Reserved.
30	DctAccessWrite: DRAM controller read/write select. RAZ; write. 0=Specifies a read access. 1=Specifies a write access.
29:0	DctOffset: DRAM controller offset. Read-write.

D18F2x9C_dct[0] DRAM Controller Additional Data Port

Reset: 0000_0000h. See [D18F2x98_dct\[0\]](#) for register access information. See 2.9.3 [DCT Configuration Registers].

Bits	Description
31:0	Data. Read-write.

D18F2x9C_x0000_0000_dct[0]_mp[1:0] DRAM Output Driver Compensation Control

See 2.9.7.6.6 [DRAM Address Timing and Output Driver Compensation Control].

Bits	Description												
31	Reserved.												
30:28	<p>ProcOdt: processor on-die termination. Read-write. Cold reset: 011b. Specifies the resistance of the on-die termination resistors. This field is valid only when D18F2x94_dct[0][ProcOdtDis]=0.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>240 ohms +/- 20%</td></tr> <tr> <td>001b</td><td>120 ohms +/- 20%</td></tr> <tr> <td>010b</td><td>80 ohms +/- 20%</td></tr> <tr> <td>011b</td><td>60 ohms +/- 20%</td></tr> <tr> <td>111b-100b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	240 ohms +/- 20%	001b	120 ohms +/- 20%	010b	80 ohms +/- 20%	011b	60 ohms +/- 20%	111b-100b	Reserved
Bits	Description												
000b	240 ohms +/- 20%												
001b	120 ohms +/- 20%												
010b	80 ohms +/- 20%												
011b	60 ohms +/- 20%												
111b-100b	Reserved												
27:23	Reserved.												
22:20	<p>DqsDrvStren: DQS drive strength. Read-write. Cold reset: 011b. Specifies the drive strength of the DQS pins.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0.75x</td></tr> <tr> <td>001b</td><td>1.0x</td></tr> <tr> <td>010b</td><td>1.25x</td></tr> <tr> <td>011b</td><td>1.5x</td></tr> <tr> <td>111b-100b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	0.75x	001b	1.0x	010b	1.25x	011b	1.5x	111b-100b	Reserved
Bits	Description												
000b	0.75x												
001b	1.0x												
010b	1.25x												
011b	1.5x												
111b-100b	Reserved												
19	Reserved.												
18:16	<p>DataDrvStren: data drive strength. Read-write. Cold reset: 011b. This field specifies the drive strength of the DRAM data pins.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0.75x</td></tr> <tr> <td>001b</td><td>1.0x</td></tr> <tr> <td>010b</td><td>1.25x</td></tr> <tr> <td>011b</td><td>1.5x</td></tr> <tr> <td>111b-100b</td><td>Reserved</td></tr> </table> <p>This field is applied to DM signals as well.</p>	Bits	Description	000b	0.75x	001b	1.0x	010b	1.25x	011b	1.5x	111b-100b	Reserved
Bits	Description												
000b	0.75x												
001b	1.0x												
010b	1.25x												
011b	1.5x												
111b-100b	Reserved												
15	Reserved.												

14:12	ClkDrvStren: MEMCLK drive strength. Read-write. Cold reset: 011b. This field specifies the drive strength of the MEMCLK pins. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>1.0x</td></tr> <tr> <td>001b</td><td>1.25x</td></tr> <tr> <td>010b</td><td>1.5x</td></tr> <tr> <td>011b</td><td>2.0x</td></tr> <tr> <td>100b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>0.75x</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	000b	1.0x	001b	1.25x	010b	1.5x	011b	2.0x	100b	Reserved	101b	0.75x	111b-110b	Reserved
<u>Bits</u>	<u>Description</u>																
000b	1.0x																
001b	1.25x																
010b	1.5x																
011b	2.0x																
100b	Reserved																
101b	0.75x																
111b-110b	Reserved																
11	Reserved.																
10:8	AddrCmdDrvStren: address/command drive strength. Read-write. Cold reset: 011b. This field specifies the drive strength of the address, RAS, CAS, WE, bank and parity pins. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>1.0x</td></tr> <tr> <td>001b</td><td>1.25x</td></tr> <tr> <td>010b</td><td>1.5x</td></tr> <tr> <td>011b</td><td>2.0x</td></tr> <tr> <td>100b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>0.75x</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	000b	1.0x	001b	1.25x	010b	1.5x	011b	2.0x	100b	Reserved	101b	0.75x	111b-110b	Reserved
<u>Bits</u>	<u>Description</u>																
000b	1.0x																
001b	1.25x																
010b	1.5x																
011b	2.0x																
100b	Reserved																
101b	0.75x																
111b-110b	Reserved																
7	Reserved.																
6:4	CsOdtDrvStren: CS/ODT drive strength. Read-write. Cold reset: 011b. This field specifies the drive strength of the CS and ODT pins. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>1.0x</td></tr> <tr> <td>001b</td><td>1.25x</td></tr> <tr> <td>010b</td><td>1.5x</td></tr> <tr> <td>011b</td><td>2.0x</td></tr> <tr> <td>100b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>0.75x</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	000b	1.0x	001b	1.25x	010b	1.5x	011b	2.0x	100b	Reserved	101b	0.75x	111b-110b	Reserved
<u>Bits</u>	<u>Description</u>																
000b	1.0x																
001b	1.25x																
010b	1.5x																
011b	2.0x																
100b	Reserved																
101b	0.75x																
111b-110b	Reserved																
3	Reserved.																
2:0	CkeDrvStren: CKE drive strength. Read-write. Cold reset: 011b. This field specifies the drive strength of the CKE pins. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>1.0x</td></tr> <tr> <td>001b</td><td>1.25x</td></tr> <tr> <td>010b</td><td>1.5x</td></tr> <tr> <td>011b</td><td>2.0x</td></tr> <tr> <td>100b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>0.75x</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	000b	1.0x	001b	1.25x	010b	1.5x	011b	2.0x	100b	Reserved	101b	0.75x	111b-110b	Reserved
<u>Bits</u>	<u>Description</u>																
000b	1.0x																
001b	1.25x																
010b	1.5x																
011b	2.0x																
100b	Reserved																
101b	0.75x																
111b-110b	Reserved																

D18F2x9C_x0000_0[3:0]0[3:1]_det[0]_mp[1:0] DRAM Write Data Timing

 BIOS: See [2.9.7.9.5 \[DQS Position Training\]](#).

Table 137: Index Mapping for [D18F2x9C_x0000_0\[3:0\]0\[3:1\]_dct\[0\]_mp\[1:0\]](#)

D18F2x98_dct[0][31:0]	Function
0000_0001h	DIMM/CS 0 Bytes 3-0
0000_0002h	DIMM/CS 0 Bytes 7-4
0000_0003h	DIMM/CS 0 ECC
0000_0101h	DIMM/CS 1 Bytes 3-0
0000_0102h	DIMM/CS 1 Bytes 7-4
0000_0103h	DIMM/CS 1 ECC
0000_0201h	Reserved/CS 2 Bytes 3-0
0000_0202h	Reserved/CS 2 Bytes 7-4
0000_0203h	Reserved/CS 2 ECC
0000_0301h	Reserved/CS 3 Bytes 3-0
0000_0302h	Reserved/CS 3 Bytes 7-4
0000_0303h	Reserved/CS 3 ECC

Table 138: Byte Lane Mapping for [D18F2x9C_x0000_0\[3:0\]0\[3:1\]_dct\[0\]_mp\[1:0\]](#)

Register	Bits			
	31:24	23:16	15:8	7:0
D18F2x9C_x0000_0[3:0]01_dct[0]_mp[1:0]	Byte3	Byte2	Byte1	Byte0
D18F2x9C_x0000_0[3:0]02_dct[0]_mp[1:0]	Byte7	Byte6	Byte5	Byte4
D18F2x9C_x0000_0[3:0]03_dct[0]_mp[1:0]	Reserved	Reserved	Reserved	ECC

If [D18F2xA8_dct\[0\]\[PerRankTimingEn\]](#)=1 then the function is CS. Otherwise the function is DIMM. These registers control the timing of write DQ with respect to MEMCLK and allow transmit DQS to be centered in the data eye. The delay starts 1 UI before the rising edge of MEMCLK corresponding to the CAS-write-latency. See 2.9.7.9 [DRAM Training]. [WrDatGrossDly](#) must be programmed for a given DIMM and lane such that $WrDatDly - WrDqsDly \leq 0.5 \text{ MEMCLKs}$.

Bits	Description
31:29	WrDatGrossDly: write data gross delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][7:5] .
28:24	WrDatFineDly: write data fine delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][4:0] .
23:21	WrDatGrossDly: write data gross delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][7:5] .
20:16	WrDatFineDly: write data fine delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][4:0] .
15:13	WrDatGrossDly: write data gross delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][7:5] .
12:8	WrDatFineDly: write data fine delay. See: D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0][4:0] .

7:5	WrDatGrossDly: write data gross delay. Read-write. Reset: 0.
<u>Bits</u>	<u>Description</u>
000b	No delay
001b	0.5 MEMCLK delay
110b-010b	<WrDatGrossDly>/2 MEMCLK delay
111b	3.5 MEMCLK delay

4:0	WrDatFineDly: write data fine delay. Read-write. Cold reset: 0.
<u>Bits</u>	<u>Description</u>
00h	0/64 MEMCLK delay
1Eh-01h	<WrDatFineDly>/64 MEMCLK delay
1Fh	31/64 MEMCLK delay

D18F2x9C_x0000_0004_dct[0]_mp[1:0] DRAM Address/Command Timing Control

BIOS: [2.9.7.6.6](#).

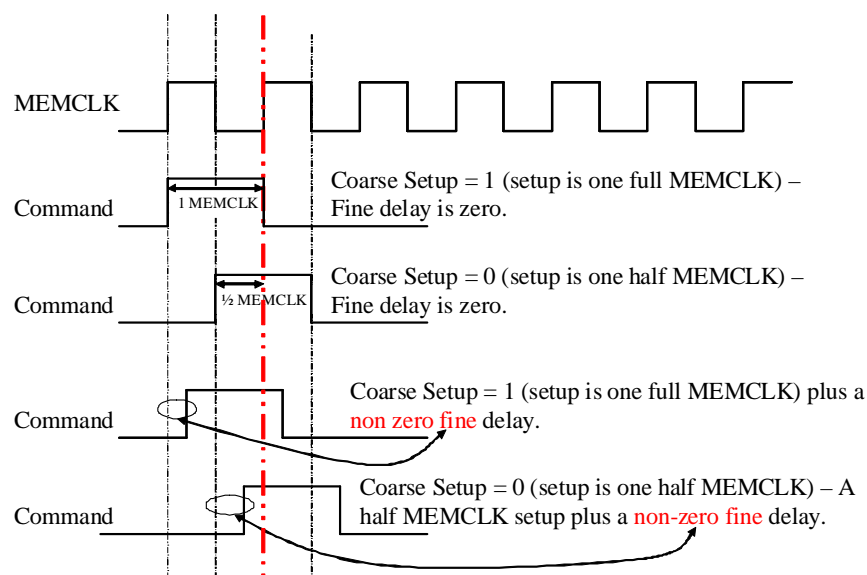


Figure 9: Address/Command Timing at the Processor Pins

This register controls the timing of the address, command, chip select, ODT and clock enable pins with respect to MEMCLK as shown in Figure 9. See [2.9.7.4.2 \[DRAM Channel Frequency Change\]](#) and [2.9.7.4.3 \[Phy Fence Programming\]](#). 2T timing is controlled by [D18F2x94_dct\[0\]\[SlowAccessMode\]](#). If a setup time (coarse delay) field is changed and [D18F2x94_dct\[0\]\[MemClkFreqVal\]=1](#), then software must toggle MemClkFreqVal for the delay to take effect.

Bits	Description
31:22	Reserved.
21	AddrCmdSetup: address/command setup time. Read-write. Reset: 0. Selects the default setup time for the address and command pins versus MEMCLK. 0=1/2 MEMCLK (1 1/2 MEMCLK for 2T timing). 1=1 MEMCLK (2 MEMCLKs for 2T timing).

20:16	AddrCmdFineDelay: address/command fine delay. Specifies the time that the address and command pins are delayed from the default setup time. See: CkeFineDelay.								
15:14	Reserved.								
13	CsOdtSetup: CS/ODT setup time. Selects the default setup time for the CS and ODT pins versus MEMCLK. See: CkeSetup.								
12:8	CsOdtFineDelay: CS/ODT fine delay. Specifies the time that the CS and ODT pins are delayed from the default setup time. See: CkeFineDelay.								
7:6	Reserved.								
5	CkeSetup: CKE setup time. Read-write. Reset: 0. Selects the default setup time for the CKE pins versus MEMCLK. 0=1/2 MEMCLK. 1=1 MEMCLK.								
4:0	CkeFineDelay: CKE fine delay. Read-write. Cold reset: 00h. Specifies the time that the CKE pins are delayed from the default setup time. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0/64 MEMCLK delay</td></tr> <tr> <td>1Eh-01h</td><td><CkeFineDelay>/64 MEMCLK delay</td></tr> <tr> <td>1Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	Bits	Description	00h	0/64 MEMCLK delay	1Eh-01h	<CkeFineDelay>/64 MEMCLK delay	1Fh	31/64 MEMCLK delay
Bits	Description								
00h	0/64 MEMCLK delay								
1Eh-01h	<CkeFineDelay>/64 MEMCLK delay								
1Fh	31/64 MEMCLK delay								

D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0] DRAM Read DQS Timing

Table 139: Index Mapping for D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0000_0005h	DIMM/CS 0 Bytes 3-0
0000_0006h	DIMM/CS 0 Bytes 7-4
0000_0007h	DIMM/CS 0 ECC
0000_0105h	DIMM/CS 1 Bytes 3-0
0000_0106h	DIMM/CS 1 Bytes 7-4
0000_0107h	DIMM/CS 1 ECC
0000_0205h	Reserved/CS 2 Bytes 3-0
0000_0206h	Reserved/CS 2 Bytes 7-4
0000_0207h	Reserved/CS 2 ECC
0000_0305h	Reserved/CS 3 Bytes 3-0
0000_0306h	Reserved/CS 3 Bytes 7-4
0000_0307h	Reserved/CS 3 ECC

Table 140: Byte Lane Mapping for D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0]

Register	Bits			
	29:25	21:17	13:9	5:1
D18F2x9C_x0000_0[3:0]05_dct[0]_mp[1:0]	Byte3	Byte2	Byte1	Byte0
D18F2x9C_x0000_0[3:0]06_dct[0]_mp[1:0]	Byte7	Byte6	Byte5	Byte4
D18F2x9C_x0000_0[3:0]07_dct[0]_mp[1:0]	Reserved	Reserved	Reserved	ECC

If [D18F2xA8_dct\[0\]\[PerRankTimingEn\]=1](#) then the function is CS. Otherwise the function is DIMM. These registers control the timing of read (input) DQS signals with respect to DQ. See [2.9.7.9 \[DRAM Training\]](#). Writes to [D18F2x9C_x0000_0\[3:0\]0\[7:5\]_dct\[0\]_mp\[1:0\]](#) set

D18F2x9C_x0D0F_0[F,8:0]2[3:0]_dct[0]_mp[1:0][RdDqsTimeU, RdDqsTimeL] = {RdDqsTime, RdDqsTime}. Reads from **D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0]** return

D18F2x9C_x0D0F_0[F,8:0]2[3:0]_dct[0]_mp[1:0][RdDqsTimeL].

The actual delay applied to the DQS input signal before sampling data includes an internal part dependent delay plus the nominal delay specified by the register setting.

Bits	Description								
31:30	Reserved.								
29:25	RdDqsTime: read DQS timing control. See: D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0][5:1] .								
24:22	Reserved.								
21:17	RdDqsTime: read DQS timing control. See: D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0][5:1] .								
16:14	Reserved.								
13:9	RdDqsTime: read DQS timing control. See: D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0][5:1] .								
8:6	Reserved.								
5:1	RdDqsTime: read DQS timing control. Read-write. Cold reset: 0Fh. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0/64 MEMCLK delay</td></tr> <tr> <td>1Eh-01h</td><td><RdDqsTime>/64 MEMCLK delay</td></tr> <tr> <td>1Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	Bits	Description	00h	0/64 MEMCLK delay	1Eh-01h	<RdDqsTime>/64 MEMCLK delay	1Fh	31/64 MEMCLK delay
Bits	Description								
00h	0/64 MEMCLK delay								
1Eh-01h	<RdDqsTime>/64 MEMCLK delay								
1Fh	31/64 MEMCLK delay								
0	Reserved.								

D18F2x9C_x0000_0008_dct[0]_mp[1:0] DRAM Phy Control

Cold reset: 0208_0000h. See [2.9.7.9 \[DRAM Training\]](#).

Bits	Description										
31	Reserved.										
30	DisAutoComp: disable automatic compensation. Read-write. BIOS: See 2.9.7.4.4 . 1=Disable the compensation control state machine. 0=The phy automatic compensation engine is enabled.										
29	DisablePredriverCal: disable predriver calibration. Read-write. BIOS: See 2.9.7.4.4 . 1=Disable the update of predriver codes to all pads.										
28:14	Reserved.										
13	DqsRevTrEn: DQS receiver training enable. Read-write. 1=Initiate hardware assisted read DQS receiver training. 0=Stop read DQS receiver training. This allows BIOS to reliably read the DQS receiver training data.										
12	WrLvOdtEn: write levelization ODT enabled. Read-write. 1=ODT specified by WrLvOdt is enabled during write levelization training. 0=ODT is disabled during write levelization training.										
11:8	WrLvOdt: write levelization ODT. Read-write. Specifies the state of the ODT pins when WrLvOdtEn is set. 1=ODT is enabled. 0=ODT is disabled. See 2.9.7.6.5 [DRAM ODT Control] . Tri-state enable for ODT is turned off by the phy when WrLvOdtEn=1. <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMODT[0][0]</td></tr> <tr> <td>[1]</td><td>MEMODT[0][1]</td></tr> <tr> <td>[2]</td><td>MEMODT[0][2]</td></tr> <tr> <td>[3]</td><td>MEMODT[0][3]</td></tr> </table>	Bit	Pad	[0]	MEMODT[0][0]	[1]	MEMODT[0][1]	[2]	MEMODT[0][2]	[3]	MEMODT[0][3]
Bit	Pad										
[0]	MEMODT[0][0]										
[1]	MEMODT[0][1]										
[2]	MEMODT[0][2]										
[3]	MEMODT[0][3]										

7:6	FenceTrSel: fence train select. Read-write. Specifies the flop to be used for phy based fence training. See PhyFenceTrEn. This field is shared by D18F2x9C_x0000_0008_dct[0]_mp0 and D18F2x9C_x0000_0008_dct[0]_mp1. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>DLL Bypass Fence Flop</td></tr> <tr> <td>01b</td><td>RxDll flop</td></tr> <tr> <td>10b</td><td>TxDll flop</td></tr> <tr> <td>11b</td><td>TxPad flop</td></tr> </table>	Bits	Description	00b	DLL Bypass Fence Flop	01b	RxDll flop	10b	TxDll flop	11b	TxPad flop
Bits	Description										
00b	DLL Bypass Fence Flop										
01b	RxDll flop										
10b	TxDll flop										
11b	TxPad flop										
5:4	TrChipSel: training DIMM select. Read-write. Specifies a timing control for a corresponding rank which is to be trained. If D18F2xA8_dct[0][PerRankTimingEn]=1 then the function is CS. Otherwise the function is DIMM. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>DIMM/CS 0</td></tr> <tr> <td>01b</td><td>DIMM/CS 1</td></tr> <tr> <td>10b</td><td>DIMM:Reserved/CS 2</td></tr> <tr> <td>11b</td><td>DIMM:Reserved/CS 3</td></tr> </table>	Bits	Description	00b	DIMM/CS 0	01b	DIMM/CS 1	10b	DIMM:Reserved/CS 2	11b	DIMM:Reserved/CS 3
Bits	Description										
00b	DIMM/CS 0										
01b	DIMM/CS 1										
10b	DIMM:Reserved/CS 2										
11b	DIMM:Reserved/CS 3										
3	PhyFenceTrEn: phy fence training enable. Read-write. 1=Initiate phy based fence training. 0=Stop the phy based fence training engine.										
2	TrNibbleSel: training nibble select. Read-write. BIOS: 0. Specifies nibbles of each DIMM data byte trained during write levelization training. 0=Lower nibbles. 1=Upper nibbles.										
1	Reserved.										
0	WrtLvTrEn: write levelization training enable. Read-write. 1=Initiate write levelization (tDQSS margining) training. 0=The phy stops driving DQS and exits write levelization training.										

D18F2x9C_x0000_000B_dct[0] DRAM Phy Status Register

Bits	Description
31	DynModeChange: dynamic mode change. RAZ; write. Reset: 0. 1=Phy enters the state specified by PhySelfRefreshMode.
30	PhyPSReq: phy pstate request. RAZ; write. Reset: 0. 1=Phy enters the memory P-state specified by PhyPS.
29:27	Reserved.
26	PhyPS: phy pstate. RAZ; write. Reset: 0. 1=M1. 0=M0. See PhyPSReq.
25:24	Reserved
23	PhySelfRefreshMode: phy self refresh mode. RAZ; write. Reset: 0. 1=Enter self refresh mode. 0=Exit self refresh mode. See DynModeChange.
22:0	Reserved

D18F2x9C_x0000_000C_dct[0] DRAM Phy Miscellaneous

Bits	Description
31	Reserved.

30:26	FenceThresholdTxDll: phy fence threshold transmit DLL. Read-write. Cold reset: 13h. BIOS: See 2.9.7.4.3 . This field specifies the fence delay threshold value used for DQS receiver valid. See FenceThresholdTxPad.																		
25:21	FenceThresholdRxDll: phy fence threshold DQS receiver enable. Read-write. Cold reset: 13h. BIOS: See 2.9.7.4.3 . This field specifies the fence delay threshold value used for DQS receiver enable. See FenceThresholdTxPad.																		
20:16	FenceThresholdTxPad: phy fence threshold transmit pad. Read-write. Cold reset: 13h. BIOS: See 2.9.7.4.3 . This field specifies the fence delay threshold value used for write data, write DQS, Addr/Cmd, CS, ODT, and CKE. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0/64 MEMCLK delay</td></tr> <tr> <td>1Eh-01h</td><td><FenceThresholdTxPad>/64 MEMCLK delay</td></tr> <tr> <td>1Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	Bits	Description	00h	0/64 MEMCLK delay	1Eh-01h	<FenceThresholdTxPad>/64 MEMCLK delay	1Fh	31/64 MEMCLK delay										
Bits	Description																		
00h	0/64 MEMCLK delay																		
1Eh-01h	<FenceThresholdTxPad>/64 MEMCLK delay																		
1Fh	31/64 MEMCLK delay																		
15:12	CKETri: CKE tri-state. Read-write. Cold reset: 0h. 0=The CKE signal is not tri-stated. 1=Tri-state unconnected CKE signal from the processor. See 2.9.4 [DDR Pad to Processor Pin Mapping] . <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMCKE[0][0]</td></tr> <tr> <td>[1]</td><td>MEMCKE[0][1]</td></tr> <tr> <td>[2]</td><td>MEMCKE[0][2]</td></tr> <tr> <td>[3]</td><td>MEMCKE[0][3]</td></tr> </table>	Bit	Pad	[0]	MEMCKE[0][0]	[1]	MEMCKE[0][1]	[2]	MEMCKE[0][2]	[3]	MEMCKE[0][3]								
Bit	Pad																		
[0]	MEMCKE[0][0]																		
[1]	MEMCKE[0][1]																		
[2]	MEMCKE[0][2]																		
[3]	MEMCKE[0][3]																		
11:8	ODTTri: ODT tri-state. Read-write. Cold reset: 0h. 0=The ODT signals are not tri-stated unless directed to by the DCT. 1=Tri-state unconnected ODT signals from the processor. See 2.9.4 [DDR Pad to Processor Pin Mapping] . <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMODT[0][0]</td></tr> <tr> <td>[1]</td><td>MEMODT[0][1]</td></tr> <tr> <td>[2]</td><td>MEMODT[0][2]</td></tr> <tr> <td>[3]</td><td>MEMODT[0][3]</td></tr> </table>	Bit	Pad	[0]	MEMODT[0][0]	[1]	MEMODT[0][1]	[2]	MEMODT[0][2]	[3]	MEMODT[0][3]								
Bit	Pad																		
[0]	MEMODT[0][0]																		
[1]	MEMODT[0][1]																		
[2]	MEMODT[0][2]																		
[3]	MEMODT[0][3]																		
7:0	ChipSelTri: chip select tri-state. Read-write. Cold reset: 00h. 0=The chip select signals are not tri-stated unless directed to by the DCT. 1=Tri-state unpopulated chip selects when motherboard termination is available. See 2.9.4 [DDR Pad to Processor Pin Mapping] . <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMCS[0]_L[0]</td></tr> <tr> <td>[1]</td><td>MEMCS[0]_L[1]</td></tr> <tr> <td>[2]</td><td>MEMCS[0]_L[2]</td></tr> <tr> <td>[3]</td><td>MEMCS[0]_L[3]</td></tr> <tr> <td>[4]</td><td>MEMCS[0]_L[4]</td></tr> <tr> <td>[5]</td><td>MEMCS[0]_L[5]</td></tr> <tr> <td>[6]</td><td>MEMCS[0]_L[6]</td></tr> <tr> <td>[7]</td><td>MEMCS[0]_L[7]</td></tr> </table>	Bit	Pad	[0]	MEMCS[0]_L[0]	[1]	MEMCS[0]_L[1]	[2]	MEMCS[0]_L[2]	[3]	MEMCS[0]_L[3]	[4]	MEMCS[0]_L[4]	[5]	MEMCS[0]_L[5]	[6]	MEMCS[0]_L[6]	[7]	MEMCS[0]_L[7]
Bit	Pad																		
[0]	MEMCS[0]_L[0]																		
[1]	MEMCS[0]_L[1]																		
[2]	MEMCS[0]_L[2]																		
[3]	MEMCS[0]_L[3]																		
[4]	MEMCS[0]_L[4]																		
[5]	MEMCS[0]_L[5]																		
[6]	MEMCS[0]_L[6]																		
[7]	MEMCS[0]_L[7]																		

D18F2x9C_x0000_000D_dct[0]_mp[1:0] DRAM Phy DLL Control

Cold Reset: 0000_0000h. This register defines programmable options for the phy's DLLs for power savings. There are two identical sets of configuration registers: one for the transmit DLLs (those running off of the phy's internal PCLK which is running at rate of 2*MEMCLK) and receive DLLs (those running off of the DQS from the DIMMs). These values are programmed by BIOS based on programmed DDR frequency. This register must be programmed before DRAM device initialization.

Bits	Description
31:26	Reserved.
25:24	RxDLLWakeupTime: receive DLL wakeup time. Read-write. BIOS: See 2.9.7.10. Specifies the number of PCLKs that the DLL standby signal must deassert prior to a DLL relock event or before read traffic is sent to the receive DLLs.
23	Reserved.
22:20	RxCPUpdPeriod: receive charge pump period. Read-write. BIOS: See 2.9.7.10. Specifies the number of DLL rellocks required to keep the receive DLLs locked for the period where there is no read traffic.
19:16	RxMaxDurDllNoLock: receive maximum duration DLL no lock. Read-write. BIOS: See 2.9.7.7. Specifies the number of PCLK cycles that occur before the phy DLLs rellock. A DLL rellock occurs every $2^{\text{RxMaxDurDllNoLock}}$ if there are no reads during the period. 0=DLL power saving disabled.
15:10	Reserved.
9:8	TxDLLWakeupTime: transmit DLL wakeup time. Read-write. BIOS: See 2.9.7.10. Specifies the number of PCLK's that the DLL standby signal must deassert prior to a DLL rellock event or before write traffic is sent to transmit DLLs.
7	Reserved.
6:4	TxCPUpdPeriod: transmit charge pump DLL wakeup time. Read-write. BIOS: See 2.9.7.10. Specifies the number of DLL rellocks required to keep the TxDLLs locked for the period where there is no write traffic.
3:0	TxMaxDurDllNoLock: transmit maximum duration DLL no lock. Read-write. BIOS: See 2.9.7.7. Specifies the number of PCLK cycles that occur before the phy DLLs rellock. A DLL rellock occurs every $2^{\text{TxMaxDurDllNoLock}}$ if there are no writes during the period. 0=DLL power saving disabled.

D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0] DRAM DQS Receiver Enable Timing

Table 141: Index Mapping for D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0000_0010h	DIMM/CS 0 Bytes 1-0
0000_0011h	DIMM/CS 0 Bytes 3-2
0000_0012h	DIMM/CS 0 ECC
0000_0013h	DIMM /CS 1 Bytes 1-0
0000_0014h	DIMM /CS 1 Bytes 3-2
0000_0015h	DIMM /CS 1 ECC
0000_0016h	Reserved /CS 2 Bytes 1-0
0000_0017h	Reserved /CS 2 Bytes 3-2
0000_0018h	Reserved /CS 2 ECC

Table 141: Index Mapping for D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]

0000_0019h	Reserved /CS 3 Bytes 1-0
0000_001Ah	Reserved /CS 3 Bytes 3-2
0000_001Bh	Reserved /CS 3 ECC
0000_001[F:C]h	Reserved
0000_0020h	DIMM/CS 0 Bytes 5-4
0000_0021h	DIMM/CS 0 Bytes 7-6
0000_0023h	DIMM /CS 1 Bytes 5-4
0000_0024h	DIMM /CS 1 Bytes 7-6
0000_0025h	Reserved
0000_0026h	Reserved /CS 2 Bytes 5-4
0000_0027h	Reserved /CS 2 Bytes 7-6
0000_0029h	Reserved /CS 3 Bytes 5-4
0000_002Ah	Reserved /CS 3 Bytes 7-6

Table 142: Byte Lane Mapping for D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]

Register	Bits	
	25:16	9:0
D18F2x9C_x0000_001[9,6,3,0]_dct[0]_mp[1:0]	Byte1	Byte0
D18F2x9C_x0000_001[A,7,4,1]_dct[0]_mp[1:0]	Byte3	Byte2
D18F2x9C_x0000_001[B,8,5,2]_dct[0]_mp[1:0]	Reserved	ECC
D18F2x9C_x0000_002[9,6,3,0]_dct[0]_mp[1:0]	Byte5	Byte4
D18F2x9C_x0000_002[A,7,4,1]_dct[0]_mp[1:0]	Byte7	Byte6

If [D18F2xA8_dct\[0\]\[PerRankTimingEn\]](#)=1 then the function is CS. Otherwise the function is DIMM.

Each of these registers control the timing of the receiver enable from the start of the read preamble with respect to MEMCLK. See [2.9.7.9 \[DRAM Training\]](#). These delay registers must be programmed such that across all DIMMs and lanes $\text{MAX}(\text{DqsRcvEnDelay}) - \text{MIN}(\text{DqsRcvEnDelay}) \leq 7 \text{ UI}$.

Bits	Description
31:26	Reserved.
25:21	DqsRcvEnGrossDelay: DQS receiver enable gross delay. See: D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][9:5] .
20:16	DqsRcvEnFineDelay: DQS receiver enable fine delay. See: D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][4:0] .
15:10	Reserved.

9:5	DqsRcvEnGrossDelay: DQS receiver enable gross delay. Read-write. Reset: 01h.	
	<u>Bits</u>	<u>Description</u>
	00h	No delay
	01h	0 MEMCLK delay
	1Eh-02h	<DqsRcvEnGrossDelay>/2 MEMCLK delay
	1Fh	15.5 MEMCLK delay
4:0	DqsRcvEnFineDelay: DQS receiver enable fine delay. Read-write. Cold reset: 00h.	
	<u>Bits</u>	<u>Description</u>
	00h	0/64 MEMCLK delay
	1Eh-01h	<DqsRcvEnFineDelay>/64 MEMCLK delay
	1Fh	31/64 MEMCLK delay

D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0] DRAM DQS Write Timing

BIOS: See 2.9.7.9 [DRAM Training].

Table 143: Index Mapping for D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0000_0030h	DIMM/CS 0 Bytes 1-0
0000_0031h	DIMM/CS 0 Bytes 3-2
0000_0032h	DIMM/CS 0 ECC
0000_0033h	DIMM /CS 1 Bytes 1-0
0000_0034h	DIMM /CS 1 Bytes 3-2
0000_0035h	DIMM /CS 1 ECC
0000_0036h	Reserved /CS 2 Bytes 1-0
0000_0037h	Reserved /CS 2 Bytes 3-2
0000_0038h	Reserved /CS 2 ECC
0000_0039h	Reserved /CS 3 Bytes 1-0
0000_003Ah	Reserved /CS 3 Bytes 3-2
0000_003Bh	Reserved /CS 3 ECC
0000_0040h	DIMM/CS 0 Bytes 5-4
0000_0041h	DIMM/CS 0 Bytes 7-6
0000_0043h	DIMM /CS 1 Bytes 5-4
0000_0044h	DIMM /CS 1 Bytes 7-6
0000_0046h	Reserved /CS 2 Bytes 5-4

Table 143: Index Mapping for D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0]

0000_0047h	Reserved /CS 2 Bytes 7-6
0000_0049h	Reserved /CS 3 Bytes 5-4
0000_004Ah	Reserved /CS 3 Bytes 7-6

Table 144: Byte Lane Mapping for D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0]

Register	Bits	
	23:16	7:0
D18F2x9C_x0000_003[9,6,3,0]_dct[0]_mp[1:0]	Byte1	Byte0
D18F2x9C_x0000_003[A,7,4,1]_dct[0]_mp[1:0]	Byte3	Byte2
D18F2x9C_x0000_003[B,8,5,2]_dct[0]_mp[1:0]	Reserved	ECC
D18F2x9C_x0000_004[9,6,3,0]_dct[0]_mp[1:0]	Byte5	Byte4
D18F2x9C_x0000_004[A,7,4,1]_dct[0]_mp[1:0]	Byte7	Byte6

If [D18F2xA8_dct\[0\]\[PerRankTimingEn\]=1](#) then the function is CS. Otherwise the function is DIMM.

Each of these registers control the DQS timing delay for write commands relative to MEMCLK. The delay starts at the rise edge of MEMCLK corresponding to the CAS-writelateness. Each control includes a gross timing field and a fine timing field, the sum of which is the total delay. See [2.9.7.9 \[DRAM Training\]](#).

Bits	Description										
31:29	Reserved.										
28:24	Reserved.										
23:21	WrDqsGrossDly: DQS write gross delay. See: D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0][7:5] .										
20:16	WrDqsFineDly: DQS write fine delay. See: D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0][4:0] .										
15:13	Reserved.										
12:8	Reserved.										
7:5	WrDqsGrossDly: DQS write gross delay. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>No delay</td></tr> <tr> <td>001b</td><td>0.5 MEMCLK delay</td></tr> <tr> <td>110b-010b</td><td><WrDqsGrossDly>/2 MEMCLK delay</td></tr> <tr> <td>111b</td><td>3.5 MEMCLK delay</td></tr> </table>	Bits	Description	000b	No delay	001b	0.5 MEMCLK delay	110b-010b	<WrDqsGrossDly>/2 MEMCLK delay	111b	3.5 MEMCLK delay
Bits	Description										
000b	No delay										
001b	0.5 MEMCLK delay										
110b-010b	<WrDqsGrossDly>/2 MEMCLK delay										
111b	3.5 MEMCLK delay										
4:0	WrDqsFineDly: DQS write fine delay. Read-write. Cold reset: 0. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0/64 MEMCLK delay</td></tr> <tr> <td>1Eh-01h</td><td><WrDqsFineDly>/64 MEMCLK delay</td></tr> <tr> <td>1Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	Bits	Description	00h	0/64 MEMCLK delay	1Eh-01h	<WrDqsFineDly>/64 MEMCLK delay	1Fh	31/64 MEMCLK delay		
Bits	Description										
00h	0/64 MEMCLK delay										
1Eh-01h	<WrDqsFineDly>/64 MEMCLK delay										
1Fh	31/64 MEMCLK delay										

D18F2x9C_x0000_00[52:50]_dct[0] DRAM Phase Recovery Control

These registers are used by BIOS for hardware assisted DRAM training. Writes to these registers seed the phase recovery engine prior to training. Reads from the registers indicate how much the phase recovery engine

has advanced to align the MEMCLK and DQS edges and is under hardware control. See [2.9.7.9 \[DRAM Training\]](#).

Table 145: Index Mapping for D18F2x9C_x0000_00[52:50]_dct[0]

D18F2x98_dct[0][31:0]	Function
0000_0050h	Bytes 3-0
0000_0051h	Bytes 7-4
0000_0052h	ECC

Table 146: Byte Lane Mapping for D18F2x9C_x0000_00[52:50]_dct[0]

Register	Bits			
	31:24	23:16	15:8	7:0
D18F2x9C_x0000_0050_dct[0]	Byte3	Byte2	Byte1	Byte0
D18F2x9C_x0000_0051_dct[0]	Byte7	Byte6	Byte5	Byte4
D18F2x9C_x0000_0052_dct[0]	Reserved	Reserved	Reserved	ECC

Bits	Description										
31	Reserved.										
30:29	PhRecGrossDly: phase recovery gross delay. See: PhRecGrossDly.										
28:24	PhRecFineDly: phase recovery fine delay. See: PhRecFineDly.										
23	Reserved.										
22:21	PhRecGrossDly: phase recovery gross delay. See: PhRecGrossDly.										
20:16	PhRecFineDly: phase recovery fine delay. See: PhRecFineDly.										
15	Reserved.										
14:13	PhRecGrossDly: phase recovery gross delay. See: PhRecGrossDly.										
12:8	PhRecFineDly: phase recovery fine delay. See: PhRecFineDly.										
7	Reserved.										
6:5	PhRecGrossDly: phase recovery gross delay. Read-write. Reset: X. Gross timing indicates the number of half-MEMCLK periods that the phase recovery engine advanced while aligning edges. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No delay</td></tr> <tr> <td>01b</td><td>0.5 MEMCLK delay</td></tr> <tr> <td>10b</td><td>1.0 MEMCLK delay</td></tr> <tr> <td>11b</td><td>1.5 MEMCLK delay</td></tr> </table>	Bits	Description	00b	No delay	01b	0.5 MEMCLK delay	10b	1.0 MEMCLK delay	11b	1.5 MEMCLK delay
Bits	Description										
00b	No delay										
01b	0.5 MEMCLK delay										
10b	1.0 MEMCLK delay										
11b	1.5 MEMCLK delay										
4:0	PhRecFineDly: phase recovery fine delay. Read-write. Reset: X. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0/64 MEMCLK delay</td></tr> <tr> <td>1Eh-01h</td><td><PhRecFineDly>/64 MEMCLK delay</td></tr> <tr> <td>1Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	Bits	Description	00h	0/64 MEMCLK delay	1Eh-01h	<PhRecFineDly>/64 MEMCLK delay	1Fh	31/64 MEMCLK delay		
Bits	Description										
00h	0/64 MEMCLK delay										
1Eh-01h	<PhRecFineDly>/64 MEMCLK delay										
1Fh	31/64 MEMCLK delay										

D18F2x9C_x0D0F_0[F,8:0]02_dct[0] Data Byte Transmit PreDriver Calibration

Cold reset: xxxx_xxxxh. BIOS: See [2.9.7.4.4](#).

Table 147: Index Mapping for D18F2x9C_x0D0F_0[F,8:0]02_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	0802h	0702h	0602h	0502h	0402h	0302h	0202h	0102h	0002h
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 148: Broadcast Mapping for D18F2x9C_x0D0F_0[F,8:0]02_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]
	0F02h
0D0Fh	D18F2x9C_x0D0F_0[8:0]02

Table 149: Valid Values for D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP]

Bits	Description
0h	Slew Rate 0 (slowest)
8h-1h	Reserved
9h	Slew Rate 1
11h-Ah	Reserved
12h	Slew Rate 2
1Ah-13h	Reserved
1Bh	Slew Rate 3
23h-1Ch	Reserved
24h	Slew Rate 4
2Ch-25h	Reserved
2Dh	Slew Rate 5
35h-2Eh	Reserved
36h	Slew Rate 6
3Eh-37h	Reserved
3Fh	Slew Rate 7 (fastest)

Bits	Description
31:16	Reserved.
15	ValidTxAndPre: predriver calibration code valid. Read-write; cleared-by-hardware. 1=Predriver calibration codes are copied from this register and D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0] into the associated transmit pad. Hardware clears this field after the copy is complete.
14:12	Reserved.
11:6	TxPreP: PMOS predriver calibration code. Read-write. Specifies the rising edge slew rate of the transmit pad. See: Table 149 [Valid Values for D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP]]. After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.
5:0	TxPreN: NMOS predriver calibration code. Read-write. Specifies the falling edge slew rate of the transmit pad. See: Table 149 [Valid Values for D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP]]. After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.

D18F2x9C_x0D0F_0[F,8:0]0[B,7,3]_dct[0] Data Byte P0dt ConfigurationCold reset: 0000_xxxxh. See [D18F2x9C_x0D0F_1C00_dct\[0\]](#).**Table 150: Index Mapping for [D18F2x9C_x0D0F_0\[F,8:0\]0\[B,7,3\]_dct\[0\]](#)**

D18F2x98_dct[0][31:0]	Function
0D0F_000[B,7,3]h	Byte 0
0D0F_010[B,7,3]h	Byte 1
0D0F_020[B,7,3]h	Byte 2
0D0F_030[B,7,3]h	Byte 3
0D0F_040[B,7,3]h	Byte 4
0D0F_050[B,7,3]h	Byte 5
0D0F_060[B,7,3]h	Byte 6
0D0F_070[B,7,3]h	Byte 7
0D0F_080[B,7,3]h	ECC
0D0F_0F0[B,7,3]h	D18F2x9C_x0D0F_0[8:0]0[B,7,3]

Bits	Description
31:16	Reserved.
15:14	Reserved.
13:8	P0dtD: pmos ODT calibration data. Read-write.
7:6	Reserved.
5:0	N0dtD: nmos ODT calibration data. Read-write.

D18F2x9C_x0D0F_0[F,8:0]04_dct[0]_mp[1:0] Data Byte Pad Configuration

Cold reset: 0000_0033h.

Table 151: Index Mapping for [D18F2x9C_x0D0F_0\[F,8:0\]04_dct\[0\]_mp\[1:0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_0004h	Byte 0
0D0F_0104h	Byte 1
0D0F_0204h	Byte 2
0D0F_0304h	Byte 3
0D0F_0404h	Byte 4
0D0F_0504h	Byte 5
0D0F_0604h	Byte 6
0D0F_0704h	Byte 7
0D0F_0804h	ECC
0D0F_0F04h	D18F2x9C_x0D0F_0[8:0]04

Bits	Description
31:14	Reserved.

13	TriDM: tri-state DM. Read-write. BIOS: 2.9.7.10 . Read-write. Specifies tri-state control for the memory DM signal. 1=Signal is tri-stated. 0=Signal is not tri-stated.
12	POdtOff: processor ODT off. Read-write. BIOS: See 2.9.7.6.6.1 =Phy disables receiver pad termination. 0=Phy enables receiver pad termination. Hardware programs this field for the current M-state (D18F2x9C_x0D00_E008_dct[0][PhyPS]) with the value in D18F2x94_dct[0][ProcOdtDis] when the memory frequency is updated. See 2.9.7.4.2 . BIOS must reprogram this field and D18F2x9C_x0D0F_E000_dct[0]_mp[1:0][POdtOff] after each frequency change or write to D18F2x9C_x0000_0008_dct[0]_mp[1:0] if the target value differs from D18F2x94_dct[0][ProcOdtDis] .
11:0	Reserved.

D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0] Data Byte Transmit PreDriver Calibration 2

Cold reset: xxxx_xxxxh. BIOS: See [2.9.7.4.4](#).

Table 152: [Index Mapping](#) for D18F2x9C_x0D0F_0[F,8:0]06_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	0806h	0706h	0606h	0506h	0406h	0306h	0206h	0106h	0006h
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 153: [Index Mapping](#) for D18F2x9C_x0D0F_0[F,8:0]0A_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	080Ah	070Ah	060Ah	050Ah	040Ah	030Ah	020Ah	010Ah	000Ah
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 154: [Broadcast Mapping](#) for D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]	
	0F0Ah	0F06h
0D0Fh	D18F2x9C_x0D0F_0[8:0]0A	D18F2x9C_x0D0F_0[8:0]06

Bits	Description
31:12	Reserved.
11:6	TxPreP: PMOS predriver calibration code. Read-write. This field specifies the rising edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP] . After updating this value, BIOS must program D18F2x9C_x0D0F_0[F,8:0]02_dct[0][ValidTxAndPre]=1 for the change to take effect.
5:0	TxPreN: NMOS predriver calibration code. Read-write. This field specifies the falling edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreN] . After updating this value, BIOS must program D18F2x9C_x0D0F_0[F,8:0]02_dct[0][ValidTxAndPre]=1 for the change to take effect.

D18F2x9C_x0D0F_0[F,8:0]10_dct[0]_mp[1:0] Data Byte DLL Power Management

Cold reset: 0000_0000h.

Table 155: Index Mapping for D18F2x9C_x0D0F_0[F,8:0]10_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0D0F_0010h	Byte 0
0D0F_0110h	Byte 1
0D0F_0210h	Byte 2
0D0F_0310h	Byte 3
0D0F_0410h	Byte 4
0D0F_0510h	Byte 5
0D0F_0610h	Byte 6
0D0F_0710h	Byte 7
0D0F_0810h	Byte 8
0D0F_0F10h	Byte 8-0

Bits	Description
31:13	Reserved.
12	EnRxPadStandby: enable receiver pad standby. Read-write. BIOS: See 2.9.7.7.1=Phy receiver standby mode is enabled to save power when not receiving data. 0=Phy receiver standby mode is disabled.
11:0	Reserved.

D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0] Data Byte DLL Configuration**Table 156: Index Mapping for D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0]**

D18F2x98_dct[0][31:0]	Function
0D0F_0013h	Byte 0
0D0F_0113h	Byte 1
0D0F_0213h	Byte 2
0D0F_0313h	Byte 3
0D0F_0413h	Byte 4
0D0F_0513h	Byte 5
0D0F_0613h	Byte 6
0D0F_0713h	Byte 7
0D0F_0813h	Byte 8
0D0F_0F13h	Byte 8-0

Bits	Description
31:15	Reserved.
14	ProcOdtAdv: ProcOdt advance. Read-write. Cold reset: 1. BIOS: IF ((Solder-down DRAM SODIMM) && DdrRate <= 1333) THEN 0 ELSE 1 ENDIF. 0=ProcOdt is asserted 1.5 PCLK before DqsEn. 1=If preceding write, ProcOdt is asserted 2.5 PCLK before DqsEn, else, ProcOdt is asserted 5.0 PCLK before DqsEn.

13	ExtraProcOdtAdv: extra ProcOdt advance. Read-write. Cold reset: 0. BIOS: 0. Reserved if ProcOdtAdv=0. 1=For a read without preceding read or write commands, ProcOdt is asserted with the CAS command. 0=Extra ProcOdt is disabled.
12:9	Reserved.
8	RxSsbMntClkEn: receive channel maintenance clock enable. Read-write. Cold reset: 0. BIOS: 2.9.7.10 . 1=Enable receive channel maintenance clocks to improve internal timing margin at the cost of some extra power. To enable clock generation, BIOS must first enable maintenance clocks in the DCT (see D18F2x248_dct[0]_mp[1:0][RxChMntClkEn]). 0=Disable clocks. The maintenance clock period is fixed at 8 PCLKs when no traffic occurs.
7:2	Reserved.
1	DllDisEarlyU: DLL disable early upper. Read-write. Cold reset: 0. BIOS: See 2.9.7.10 . 1=Disable upper receiver DQS DLL early timing for power savings.
0	DllDisEarlyL: DLL disable early lower. Read-write. Cold reset: 0. BIOS: See 2.9.7.10 . 1=Disable lower receiver DQS DLL early timing for power savings.

D18F2x9C_x0D0F_0[F,8:0]1C_dct[0]_mp[1:0] Data Byte DLL Power Management

Cold reset: 0000_0000h.

Table 157: Index Mapping for [D18F2x9C_x0D0F_0\[F,8:0\]1C_dct\[0\]_mp\[1:0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_001Ch	Byte 0
0D0F_011Ch	Byte 1
0D0F_021Ch	Byte 2
0D0F_031Ch	Byte 3
0D0F_041Ch	Byte 4
0D0F_051Ch	Byte 5
0D0F_061Ch	Byte 6
0D0F_071Ch	Byte 7
0D0F_081Ch	Byte 8
0D0F_0F1Ch	Byte 8-0

Bits	Description
15	RxDllStggrEn: Rx DLL stagger enable. Read-write. BIOS: 2.9.7.10 . 1=Insert RxDllStggrDly delay prior to waking the receive DLLs from standby. 0=DLLs wake from standby at the default pending-activity reference point.
14	Reserved.
13:8	RxDllStggrDly[5:0]: Rx DLL stagger delay. Read-write. BIOS: 2.9.7.10 . Specifies the delay in PCLK cycles from a CAS command or an internal DLL maintenance lock timing event before the receive DLLs exit standby if the data bus is still idle. If data bus traffic is pending and the DLLs are in standby then they wake immediately regardless of the delay value.
7	TxDllStggrEn: Tx DLL stagger enable. Read-write. BIOS: 2.9.7.10 . 1=Insert TxDllStggrDly delay prior to waking the transmit DLL from standby. 0=DLL wakes from standby at the default pending-activity reference point.

6	Reserved.
5:0	TxDllStggrDly[5:0]: Tx DLL stagger delay. Read-write. BIOS: 0. BIOS: 2.9.7.10. Specifies the delay in PCLK cycles from a CAS command or an internal DLL maintenance lock timing event before the transmit DLL exits standby if the data bus is still idle. If data bus traffic is pending and the DLL is in standby then it wakes immediately regardless of the delay value.

D18F2x9C_x0D0F_0[F,8:0]1E_dct[0]_mp[1:0] Data Byte Receiver Bias Current Control

Cold reset: 0000_5220h.

Table 158: Index Mapping for D18F2x9C_x0D0F_0[F,8:0]1E_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0D0F_001Eh	Byte 0
0D0F_011Eh	Byte 1
0D0F_021Eh	Byte 2
0D0F_031Eh	Byte 3
0D0F_041Eh	Byte 4
0D0F_051Eh	Byte 5
0D0F_061Eh	Byte 6
0D0F_071Eh	Byte 7
0D0F_081Eh	Byte 8
0D0F_0F1Eh	Byte 8-0

Bits	Description																		
31:15	Reserved.																		
14:12	DllCSRBiasTrim: dll csr biast trim. Read-write. BIOS: 001b. The MSB bit adjusts the DAC current profile that is used only by the delayline, which adjusts the tuning curve of the delayline. The remaining two bits affect the global bias current. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>-25%</td></tr> <tr> <td>001b</td><td>Nominal</td></tr> <tr> <td>010b</td><td>+50%</td></tr> <tr> <td>011b</td><td>+100</td></tr> <tr> <td>100b</td><td>-25% + delayline adjust</td></tr> <tr> <td>101b</td><td>Nominal + delayline adjust</td></tr> <tr> <td>110b</td><td>+50% + delayline adjust</td></tr> <tr> <td>111b</td><td>+100 + delayline adjust</td></tr> </table>	Bits	Description	000b	-25%	001b	Nominal	010b	+50%	011b	+100	100b	-25% + delayline adjust	101b	Nominal + delayline adjust	110b	+50% + delayline adjust	111b	+100 + delayline adjust
Bits	Description																		
000b	-25%																		
001b	Nominal																		
010b	+50%																		
011b	+100																		
100b	-25% + delayline adjust																		
101b	Nominal + delayline adjust																		
110b	+50% + delayline adjust																		
111b	+100 + delayline adjust																		
11:8	Reserved.																		
7	DllPDBypass: dll powerdown bypass. Read-write. 1=DLL power down and bypass path enabled. 0=DLL power down and bypass path disabled. M0 and M1 must be programmed to the same value to support Memory P-state changes.																		
6:0	Reserved.																		

D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0] Data Byte Receiver Configuration

Cold reset: 0000_2003h.

Table 159: Index Mapping for [D18F2x9C_x0D0F_0\[F,8:0\]1F_dct\[0\]_mp\[1:0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_001Fh	Byte 0
0D0F_011Fh	Byte 1
0D0F_021Fh	Byte 2
0D0F_031Fh	Byte 3
0D0F_041Fh	Byte 4
0D0F_051Fh	Byte 5
0D0F_061Fh	Byte 6
0D0F_071Fh	Byte 7
0D0F_081Fh	Byte 8
0D0F_0F1Fh	Byte 8-0

Bits	Description												
31:16	Reserved.												
15	Reserved.												
14	LowPowerRcvrEn: low power receiver enable. Read-write. BIOS: 2.9.7.4 . 1=Enable low power DQ receiver for low speed operation. 0=Disable low power DQ receiver for high speed operation.												
13:8	Reserved.												
7:5	RxDqInsDly: receive DQ insertion delay. Read-write. BIOS: 2.9.7.9.5 . This control adds insertion delay to the Rx DQ path so that the delay through RxDqs+DLL insertion delay+Clk distribution better matches the DQ data propagation delay. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Min delay</td></tr> <tr> <td>001b</td><td>Delay 1</td></tr> <tr> <td>010b</td><td>Delay 2</td></tr> <tr> <td>011b</td><td>Max delay</td></tr> <tr> <td>111b-100b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	Min delay	001b	Delay 1	010b	Delay 2	011b	Max delay	111b-100b	Reserved
Bits	Description												
000b	Min delay												
001b	Delay 1												
010b	Delay 2												
011b	Max delay												
111b-100b	Reserved												
4:3	RxVioLvl: receiver voltage level. Read-write. BIOS: 2.9.7.4.1 . Specifies the VDDIO voltage level. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1.5 V</td></tr> <tr> <td>01b</td><td>1.35 V</td></tr> <tr> <td>10b</td><td>1.25 V</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	1.5 V	01b	1.35 V	10b	1.25 V	11b	Reserved		
Bits	Description												
00b	1.5 V												
01b	1.35 V												
10b	1.25 V												
11b	Reserved												
2:0	Reserved.												

D18F2x9C_x0D0F_0[F,8:0]2[3:0]_dct[0]_mp[1:0] Data Byte RxDqs DLL ConfigurationCold reset: 0000_0F0Fh. See [D18F2x9C_x0000_0\[3:0\]0\[7:5\]_dct\[0\]_mp\[1:0\]](#).Table 160: Index Mapping for [D18F2x9C_x0D0F_0\[F,8:0\]2\[3:0\]_dct\[0\]_mp\[1:0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_0020h	DIMM/CS 0 Byte 0
0D0F_0120h	DIMM/CS 0 Byte 1

Table 160: Index Mapping for D18F2x9C_x0D0F_0[F,8:0]2[3:0]_dct[0]_mp[1:0]

0D0F_0220h	DIMM/CS 0 Byte 2
0D0F_0320h	DIMM/CS 0 Byte 3
0D0F_0420h	DIMM/CS 0 Byte 4
0D0F_0520h	DIMM/CS 0 Byte 5
0D0F_0620h	DIMM/CS 0 Byte 6
0D0F_0720h	DIMM/CS 0 Byte 7
0D0F_0820h	DIMM/CS 0 Byte 8
0D0F_0F20h	DIMM/CS 0 Byte 8-0
0D0F_0021h	DIMM/CS 1 Byte 0
0D0F_0121h	DIMM/CS 1 Byte 1
0D0F_0221h	DIMM/CS 1 Byte 2
0D0F_0321h	DIMM/CS 1 Byte 3
0D0F_0421h	DIMM/CS 1 Byte 4
0D0F_0521h	DIMM/CS 1 Byte 5
0D0F_0621h	DIMM/CS 1 Byte 6
0D0F_0721h	DIMM/CS 1 Byte 7
0D0F_0821h	DIMM/CS 1 Byte 8
0D0F_0F21h	DIMM/CS 1 Byte 8-0
0D0F_0022h	Reserved/CS 2 Byte 0
0D0F_0122h	Reserved/CS 2 Byte 1
0D0F_0222h	Reserved/CS 2 Byte 2
0D0F_0322h	Reserved/CS 2 Byte 3
0D0F_0422h	Reserved/CS 2 Byte 4
0D0F_0522h	Reserved/CS 2 Byte 5
0D0F_0622h	Reserved/CS 2 Byte 6
0D0F_0722h	Reserved/CS 2 Byte 7
0D0F_0822h	Reserved/CS 2 Byte 8
0D0F_0F22h	Reserved/CS 2 Byte 8-0
0D0F_0023h	Reserved/CS 3 Byte 0
0D0F_0123h	Reserved/CS 3 Byte 1
0D0F_0223h	Reserved/CS 3 Byte 2
0D0F_0323h	Reserved/CS 3 Byte 3
0D0F_0423h	Reserved/CS 3 Byte 4
0D0F_0523h	Reserved/CS 3 Byte 5
0D0F_0623h	Reserved/CS 3 Byte 6
0D0F_0723h	Reserved/CS 3 Byte 7
0D0F_0823h	Reserved/CS 3 Byte 8
0D0F_0F23h	Reserved/CS 3 Byte 8-0

If D18F2xA8_dct[0][PerRankTimingEn]=1 then the function is CS. Otherwise the function is DIMM.

Bits	Description
31:13	Reserved.

12:8	RdDqsTimeU: read DQS timing control upper nibble. Read-write. <u>Bits</u> 1Fh-00h	<u>Description</u> <RdDqsTimeU>/64 MEMCLK delay
7:5	Reserved.	
4:0	RdDqsTimeL: read DQS timing control lower nibble. Read-write. <u>Bits</u> 1Fh-00h	<u>Description</u> <RdDqsTimeL>/64 MEMCLK delay

D18F2x9C_x0D0F_0[8:0]2[9:4]_dct[0]_mp[1:0] Data Byte DLL Configuration

Cold reset: 0000_0000h. Updated by hardware during [2.9.7.4.3 \[Phy Fence Programming\]](#).

Bits	Description
31:16	Reserved.
15	FenceBitO: fence bit odd. Read-write.
14	Fence2BitO: fence2 bit odd. Read-write.
13:8	Reserved.
7	FenceBitE: fence bit even. Read-write.
6	Fence2BitE: fence2 bit even. Read-write.
5:0	Reserved.

D18F2x9C_x0D0F_0[F,8:0]30_dct[0] Data Byte DLL Configuration and Power Down

Cold reset: 0000_0001h.

Table 161: Index Addresses for D18F2x9C_x0D0F_0[F,8:0]30_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	0830h	0730h	0630h	0530h	0430h	0330h	0230h	0130h	0030h
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 162: Broadcast Write Index Address for D18F2x9C_x0D0F_0[F,8:0]30_dct[0]

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]
	0F30h
0D0Fh	D18F2x9C_x0D0F_0[8:0]30

Bits	Description
31:10	Reserved.
9	TxPclkGateEn: tx pclk gating enable. Read-write. BIOS: 2.9.7.10 . 1=DQS TX data pipe PCLK gating is enabled. 0=PCLK gating disabled.
8	BlockRxDqsLock: block rx dqs lock. Read-write. BIOS: 2.9.7.9.3 . Specifies how the receive DLLs lock. 1=Lock on PCLK. 0=Lock on both PCLK and the received DQS
7	PchgPdPclkGateEn: precharge powerdown pclk gating enable. Read-write. BIOS: 2.9.7.10 . 1=DByte datapipe PCLK gating is enabled. 0=PCLK gating disabled.

6	DataCtlPipePclkGateEn: data control pipe pclk gating enable. Read-write. BIOS: 2.9.7.10 . 1=Data control pipe PCLK gating is enabled. 0=PCLK gating disabled.
5	Reserved.
4	PwrDn: power down. Read-write. BIOS: 2.9.7.10 . 1=Turn off DLL circuitry.
3:0	Reserved.

D18F2x9C_x0D0F_0[F,8:0]31_dct[0] Data Byte Fence2 Threshold

BIOS: [2.9.7.4.3](#).

Table 163: Index addresses for [D18F2x9C_x0D0F_0\[F,8:0\]31_dct\[0\]](#)

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	0831h	0731h	0631h	0531h	0431h	0331h	0231h	0131h	0031h
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 164: Broadcast write index address for [D18F2x9C_x0D0F_0\[F,8:0\]31_dct\[0\]](#)

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]
	0F31h
0D0Fh	D18F2x9C_x0D0F_0[8:0]31

Bits	Description										
31:10	Reserved.										
9	Fence2EnableTxDll: phy fence2 enable transmit DLL. Read-write. Cold reset: 0. 1=Enable the use of Fence2ThresholdTxDll for transmit DLL fence threshold. 0=Use D18F2x9C_x0000_000C_dct[0][FenceThresholdTxDll] .										
8:5	Fence2ThresholdTxDll: phy fence2 threshold transmit DLL. Read-write. Cold reset: 0. If Fence2EnableTxDll=1, this field specifies the fence delay threshold value used for DQS receiver valid. This field is only used during DQS receiver enable training. See Fence2ThresholdTxPad.										
4	Fence2EnableTxPad: fence2 enable transmit pad. Read-write. Cold reset: 0. 1=Enable the use of Fence2ThresholdTxPad for transmit pad fence threshold. 0=Use D18F2x9C_x0000_000C_dct[0][FenceThresholdTxPad] .										
3:0	Fence2ThresholdTxPad: phy fence2 threshold transmit pad. Read-write. Cold reset: 0. If Fence2EnableTxPad=1, this field specifies the fence delay threshold value used for write data and write DQS. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>No delay</td></tr> <tr> <td>1h</td><td>1/64 MEMCLK delay</td></tr> <tr> <td>Eh-2h</td><td><Fence2ThresholdTxPad> MEMCLK delay</td></tr> <tr> <td>Fh</td><td>15/64 MEMCLK delay</td></tr> </table>	Bits	Definition	0h	No delay	1h	1/64 MEMCLK delay	Eh-2h	<Fence2ThresholdTxPad> MEMCLK delay	Fh	15/64 MEMCLK delay
Bits	Definition										
0h	No delay										
1h	1/64 MEMCLK delay										
Eh-2h	<Fence2ThresholdTxPad> MEMCLK delay										
Fh	15/64 MEMCLK delay										

D18F2x9C_x0D0F_0[F,8:0]38_dct[0] Data Byte DLL Control Register

Table 165: Index addresses for [D18F2x9C_x0D0F_0\[F,8:0\]38_dct\[0\]](#)

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]								
	0838h	0738h	0638h	0538h	0438h	0338h	0238h	0138h	0038h
0D0Fh	ECC	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Table 166: Broadcast write index address for [D18F2x9C_x0D0F_0\[F,8:0\]38_dct\[0\]](#)

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]
	0F38h
0D0Fh	D18F2x9C_x0D0F_0[8:0]38

Bits	Description										
31:16	Reserved.										
15	Reserved.										
14:13	ReducedLoop: reduced loop. Read-write. Cold reset: 0. Specifies additional delay imposed before the phase comparator, which has the effect of locking the DLL to a shorter period. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No delay.</td></tr> <tr> <td>01b</td><td>1/3 maximum additional delay</td></tr> <tr> <td>10b</td><td>2/3 maximum additional delay</td></tr> <tr> <td>11b</td><td>Maximum additional delay</td></tr> </table>	Bits	Description	00b	No delay.	01b	1/3 maximum additional delay	10b	2/3 maximum additional delay	11b	Maximum additional delay
Bits	Description										
00b	No delay.										
01b	1/3 maximum additional delay										
10b	2/3 maximum additional delay										
11b	Maximum additional delay										
12:0	Reserved.										

D18F2x9C_x0D0F_1C00_dct[0] Data Byte P0dt Configuration

Cold reset: xxxx_xxxxh.

Table 167: Broadcast write index address for [D18F2x9C_x0D0F_1C00_dct\[0\]](#)

D18F2x98_dct[0][31:16]	D18F2x98_dct[0][15:0]
	1C00h
0D0Fh	D18F2x9C_x0D0F_0[F,8:0]0[B,7,3]_dct[0]

Bits	Description
31:14	Reserved.
13:8	P0dtD: pmos ODT calibration data. Write-only.
7:6	Reserved.
5:0	N0dtD: nmos ODT calibration data. Write-only.

D18F2x9C_x0D0F_2[2:0]02_dct[0] Clock Transmit PreDriver CalibrationCold reset: xxxx_xxxxh. BIOS: See [2.9.7.4.4](#).

Table 168: Index Mapping for D18F2x9C_x0D0F_2[2:0]02_dct[0]

D18F2x98_dct[0][31:0]	Function
0D0F_2002h	Clock 0 Pad Group 0
0D0F_2102h	Clock 1 Pad Group 0
0D0F_2202h	Reserved

Bits	Description
31:16	Reserved.
15	ValidTxAndPre: predriver calibration code valid. Read-write; cleared-by-hardware. 1=Predriver calibration codes are copied from this register into the associated transmit pad. Hardware clears this field after the copy is complete.
14:12	Reserved.
11:6	TxPreP: PMOS predriver calibration code. Read-write. This field specifies the rising edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP]. After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.
5:0	TxPreN: NMOS predriver calibration code. Read-write. This field specifies the falling edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreN]. After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.

D18F2x9C_x0D0F_[C,8,2][2:0]1E_dct[0]_mp[1:0] Phy Control

Cold reset: 0000_5020h.

Table 169: Index address mapping for D18F2x9C_x0D0F_[C,8,2][2:0]1E_dct[0]_mp[1:0]

D18F2x98_dct[0][31:0]	Function
0D0F_201Eh	Clock 0
0D0F_211Eh	Clock 1
0D0F_221Eh	Reserved
0D0F_801Eh	Cmd/Addr 0
0D0F_811Eh	Cmd/Addr 1
0D0F_821Eh	Reserved
0D0F_C01Eh	Address
0D0F_C11Eh	Reserved
0D0F_C21Eh	Reserved

Bits	Description
31:8	Reserved.
7	DIIPDBypass: dll powerdown bypass. Read-write. 1=DLL power down and bypass path enabled. 0=DLL power down and bypass path disabled. M0 and M1 must be programmed to the same value.
6:0	Reserved.

D18F2x9C_x0D0F_[C,8,2][2:0]1F_dct[0] Receiver Configuration

Cold reset: 0000_2000h.

Table 170: Index address mapping for [D18F2x9C_x0D0F_\[C,8,2\]\[2:0\]1F_dct\[0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_201Fh	Clock 0
0D0F_211Fh	Clock 1
0D0F_221Fh	Reserved
0D0F_801Fh	Cmd/Addr 0
0D0F_811Fh	Cmd/Addr 1
0D0F_821Fh	Reserved
0D0F_C01Fh	Address
0D0F_C11Fh	Reserved
0D0F_C21Fh	Reserved

Bits	Description										
31:5	Reserved.										
4:3	RxVioLvl: receiver voltage level. Read-write. BIOS: See 2.9.7.4.1 . Specifies the VDDIO voltage level. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>1.5 V</td></tr> <tr> <td>01b</td><td>1.35 V</td></tr> <tr> <td>10b</td><td>1.25 V</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	1.5 V	01b	1.35 V	10b	1.25 V	11b	Reserved
<u>Bits</u>	<u>Description</u>										
00b	1.5 V										
01b	1.35 V										
10b	1.25 V										
11b	Reserved										
2:0	Reserved.										

[D18F2x9C_x0D0F_\[C,8,2\]\[2:0\]20_dct\[0\]_mp\[1:0\]](#) DLL Delay and ConfigurationCold reset: 0000_8000h. Updated by hardware during [2.9.7.4.3 \[Phy Fence Programming\]](#).**Table 171: Index Addresses for [D18F2x9C_x0D0F_\[C,8,2\]\[2:0\]20_dct\[0\]_mp\[1:0\]](#)**

D18F2x98_dct[0][31:0]	Function
0D0F_2020h	Clock 0
0D0F_2120h	Clock 1
0D0F_2220h	Reserved
0D0F_8020h	Cmd/Addr 0
0D0F_8120h	Cmd/Addr 1
0D0F_8220h	Reserved
0D0F_C020h	Address
0D0F_C120h	Reserved
0D0F_C220h	Reserved

Bits	Description
31:16	Reserved.
15	Reserved.
14	Reserved.

13:8	Reserved.
7	FenceBit: fence bit. Read-write.
6	Fence2Bit: fence2 bit. Read-write.
5:0	Reserved.

D18F2x9C_x0D0F_2[F,2:0]30_dct[0] Clock DLL Configuration and Power Down

Cold reset: 0000_0001h.

Table 172: Index Addresses for D18F2x9C_x0D0F_2[F,2:0]30_dct[0]

D18F2x98_dct[0][31:0]	Function
0D0F_2030h	Clock 0
0D0F_2130h	Clock 1
0D0F_2230h	Reserved
0D0F_2F30h	Clock 1-0

Bits	Description
31:16	Reserved.
15:5	Reserved.
4	PwrDn: power down. Read-write. 1=Turn off DLL circuitry.
3:0	Reserved.

D18F2x9C_x0D0F_4006_dct[0] DRAM Phy MemVref Observation Configuration

Cold reset: 0000_0002h.

Bits	Description														
31:16	Reserved.														
15:9	Reserved.														
8:3	Reserved.														
2:0	VrefSel: vref selection. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Connections to the bump and internal VREF bus are driven tri-state.</td></tr> <tr> <td>001b</td><td>Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.</td></tr> <tr> <td>010b</td><td>External Rx. External Vref from the pad is sent to the DQ receivers.</td></tr> <tr> <td>011b</td><td>Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.</td></tr> <tr> <td>110b-100b</td><td>Reserved.</td></tr> <tr> <td>111b</td><td>Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.</td></tr> </table>	Bits	Description	000b	Connections to the bump and internal VREF bus are driven tri-state.	001b	Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.	010b	External Rx. External Vref from the pad is sent to the DQ receivers.	011b	Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.	110b-100b	Reserved.	111b	Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.
Bits	Description														
000b	Connections to the bump and internal VREF bus are driven tri-state.														
001b	Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.														
010b	External Rx. External Vref from the pad is sent to the DQ receivers.														
011b	Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.														
110b-100b	Reserved.														
111b	Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.														

D18F2x9C_x0D0F_4007_dct[0] DRAM Phy MemVref Configuration

Cold reset: 0000_0002h.

Bits	Description
31:16	Reserved.

15:9	Reserved.														
8:3	VrefDAC: vref DAC. Read-write. Controls the relative offset for the internal generated Vref from nominal VDDIO/2. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1Eh-00h</td><td><VrefDAC>%</td></tr> <tr> <td>20h-1Fh</td><td>Reserved</td></tr> <tr> <td>3Eh-21h</td><td>20h - <VrefDAC>%</td></tr> <tr> <td>3Fh</td><td>Reserved</td></tr> </table>	Bits	Description	1Eh-00h	<VrefDAC>%	20h-1Fh	Reserved	3Eh-21h	20h - <VrefDAC>%	3Fh	Reserved				
Bits	Description														
1Eh-00h	<VrefDAC>%														
20h-1Fh	Reserved														
3Eh-21h	20h - <VrefDAC>%														
3Fh	Reserved														
2:0	VrefSel: vref selection. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Reserved.</td></tr> <tr> <td>001b</td><td>Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.</td></tr> <tr> <td>010b</td><td>External Rx. External Vref from the pad is sent to the DQ receivers.</td></tr> <tr> <td>011b</td><td>Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.</td></tr> <tr> <td>110b-100b</td><td>Reserved.</td></tr> <tr> <td>111b</td><td>Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.</td></tr> </table>	Bits	Description	000b	Reserved.	001b	Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.	010b	External Rx. External Vref from the pad is sent to the DQ receivers.	011b	Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.	110b-100b	Reserved.	111b	Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.
Bits	Description														
000b	Reserved.														
001b	Internal Rx. VrefDAC is sent to the DQ receivers; pad connection is tri-state.														
010b	External Rx. External Vref from the pad is sent to the DQ receivers.														
011b	Internal Tx. VrefDAC is sent out on the pad; internal connection is tri-state.														
110b-100b	Reserved.														
111b	Internal Rx & Tx. VrefDAC is sent to all the DQ receivers and pad.														

D18F2x9C_x0D0F_4009_dct[0] Phy Cmp Configuration

Cold reset: 0000_2000h.

Bits	Description										
31:16	Reserved.										
15:14	CmpVioLvl: cmp voltage level. Read-write. BIOS: See 2.9.7.4.1. This field specifies the VDDIO voltage level. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1.5 V</td></tr> <tr> <td>01b</td><td>1.35 V</td></tr> <tr> <td>10b</td><td>1.25 V</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	1.5 V	01b	1.35 V	10b	1.25 V	11b	Reserved
Bits	Description										
00b	1.5 V										
01b	1.35 V										
10b	1.25 V										
11b	Reserved										
13:4	Reserved.										
3:2	ComparatorAdjust: comparator adjust. Read-write. BIOS: D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0][RxVioLvl]. This field specifies the adjustment signals for the comparator differential amplifier.										
1:0	Reserved.										

D18F2x9C_x0D0F_[C,8][1:0]02_dct[0] Transmit PreDriver Calibration

Cold reset: xxxx_xxxxh. BIOS: See 2.9.7.4.4.

Table 173: Index Mapping for D18F2x9C_x0D0F_[C,8][1:0]02_dct[0]

D18F2x98_dct[0][31:0]	Function
0D0F_8002h	Cmd/Addr 0 Pad Group 0
0D0F_8102h	Cmd/Addr 1 Pad Group 0
0D0F_C002h	Address Pad Group 0

Bits	Description
31:16	Reserved.
15	ValidTxAndPre: predriver calibration code valid. Read-write; cleared-by-hardware. 1=Predriver calibration codes are copied from this register and D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0] into the associated transmit pad. Hardware clears this field after the copy is complete.
14:12	Reserved.
11:6	TxPreP: PMOS predriver calibration code. Read-write. This field specifies the rising edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP] . After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.
5:0	TxPreN: NMOS predriver calibration code. Read-write. This field specifies the falling edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreN] . After updating this value, BIOS must program ValidTxAndPre=1 for the change to take effect.

D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0] Transmit PreDriver Calibration 2

Cold reset: xxxx_xxxxh. BIOS: See [2.9.7.4.4](#).

Table 174: [Index Mapping](#) for [D18F2x9C_x0D0F_\[C,8\]\[1:0\]\[12,0E,0A,06\]_dct\[0\]](#)

D18F2x98_dct[0][31:0]	Function
0D0F_8006h	Cmd/Addr 0 Pad Group 1
0D0F_800Ah	Cmd/Addr 0 Pad Group 2
0D0F_8106h	Cmd/Addr 1 Pad Group 1
0D0F_810Ah	Cmd/Addr 1 Pad Group 2
0D0F_C006h	Address Pad Group 1
0D0F_C00Ah	Address Pad Group 2
0D0F_C00Eh	Address Pad Group 3
0D0F_C012h	Address Pad Group 4

Bits	Description
31:12	Reserved.
11:6	TxPreP: PMOS predriver calibration code. Read-write. This field specifies the rising edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreP] . After updating this value, BIOS must program D18F2x9C_x0D0F_[C,8][1:0]02_dct[0][ValidTxAndPre] =1 for the change to take effect.
5:0	TxPreN: NMOS predriver calibration code. Read-write. This field specifies the falling edge slew rate of the transmit pad. See: D18F2x9C_x0D0F_0[F,8:0]02_dct[0][TxPreN] . After updating this value, BIOS must program D18F2x9C_x0D0F_[C,8][1:0]02_dct[0][ValidTxAndPre] =1 for the change to take effect.

D18F2x9C_x0D0F_812F_dct[0] Tristate Configuration

Reset: 0000_00A0h. BIOS: See [2.9.7.10](#).

Bits	Description
31:8	Reserved.
7	Add16Tri: MEMADD[16] tri-state. Read-write. Specifies tri-state control for the memory address[16] signal. 1=Signal is tri-stated. 0=Signal is not tri-stated.
6	Reserved.
5	Add17Tri: MEMADD[17] tri-state. Read-write. Specifies tri-state control for the memory address[17] signal. 1=Signal is tri-stated. 0=Signal is not tri-stated.
4:1	Reserved.
0	PARTri: MEMPAR tri-state. Read-write. Specifies tri-state control for the memory parity signal. 1=Signal is tri-stated. 0=Signal is not tri-stated.

D18F2x9C_x0D0F_[C,8][F:0]30_dct[0] Cmd/Addr DLL Configuration and Power Down

Cold reset: 0000_0001h. BIOS: See [2.9.7.4.4](#).

Table 175: [Index Mapping](#) for D18F2x9C_x0D0F_[C,8][F:0]30_dct[0]

D18F2x98_dct[0][31:0]	Function
0D0F_8030h	Cmd/Addr 0
0D0F_8130h	Cmd/Addr 1
0D0F_8F30h	Cmd/Addr 0 and Cmd/Addr 1
0D0F_C030h	Address 2

Bits	Description
31:16	Reserved.
15:5	Reserved.
4	PwrDn: power down. Read-write. 1=Turn off DLL circuitry.
3:0	Reserved.

D18F2x9C_x0D0F_C021_dct[0]_mp[1:0] DLL Delay and Configuration

Cold reset: 0000_0000h. Updated by hardware during [2.9.7.4.3 \[Phy Fence Programming\]](#).

Bits	Description
31:16	Reserved.
15:8	Reserved.
7	FenceBit: fence bit. Read-write.
6	Fence2Bit: fence2 bit. Read-write.
5:0	Reserved.

D18F2x9C_x0D0F_E000_dct[0]_mp[1:0] Phy Master Configuration

Cold reset: 0000_0002h.

Bits	Description
31:16	Reserved.
15:14	Rate[4:3] . See: Rate[2:0].
13	POdtOff: processor ODT off . Read-write. BIOS: See D18F2x9C_x0D0F_0[F,8:0]04_dct[0]_mp[1:0][POdtOff] . 1=Phy disables receiver pad termination. 0=Phy enables receiver pad termination.
12:4	Reserved.
3	FreqValid: Frequency valid . Read-write. 1=The memory frequency specified with the Rate field is valid. software must set this bit when programming Rate for the setting to take effect. Regardless of this bit, a new rate does not take effect unless the target register context is of the current memory P-state, or until the memory P-state is changed to the target Rate context.
2:0	Rate[2:0] . Read-write. Rate[4:0] = {Rate[4:3], Rate[2:0]}. Rate[4:0] is the 5-bit DDR data rate that the phy uses to configure the PLL. See Table 136 [Valid Values for Memory Clock Frequency Value Definition] . Software must set FreqValid=1 when programming this field. If memory P-states are enabled then software must program the M1 context. It is not necessary for software to program the M0 context when using D18F2x94_dct[0][MemClkFreqVal] .

D18F2x9C_x0D0F_E006_dct[0] Phy PLL Lock Time

Cold reset: 0000_0190h.

Bits	Description
31:16	Reserved.
15:0	PlILockTime: pll lock time . Read-write. Specifies the number of 5ns periods the phy waits for PLLs to lock during a frequency change. See 2.9.7.4.2 [DRAM Channel Frequency Change] . The PLL and DLL are locked in sequence, PLL lock specified PlILockTime followed by DLL lock.

D18F2x9C_x0D0F_E007_dct[0] Phy DLL Lock Time

Cold reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15:0	DllLockTime: dll lock time . Read-write. Specifies the number of RefClk cycles the phy waits for DLLs to lock during a frequency change. See 2.9.7.4.2 [DRAM Channel Frequency Change] . The function of this CSR is replaced with DLL Gain Sequencer. This timer runs in parallel with the gain sequencer and the status of DLL is marked as locked when the gain sequencer has completed its sequence and the DLL Lock Time counter has also expired.

D18F2x9C_x0D00_E008_dct[0] Phy Master Configuration

Cold reset: 0000_0013h.

Bits	Description
31:13	Reserved.

12	PhyPS: Phy memory P-state. Read-only; updated-by-hardware. Indicates the current memory P-state for the phy. 0=M0. 1=M1.
11:5	Reserved.
4:0	FenceValue: fence value. Read-only; updated-by-hardware. Indicates the fence value used to create the fence bit in the DLL delay registers. See 2.9.7.4.3 [Phy Fence Programming] .

D18F2x9C_x0D04_E008_dct[0] Phy Master Configuration

Cold reset: 0000_0013h.

Bits	Description
31:9	Reserved.
8	PStateToAccess: P-state to access. Read-write. Specifies the memory P-state context for context sensitive DDR phy CSR accesses using D18F2x98_dct[0] when DctOffset[29:20] != 0D0h. 0=M0, 1=M1. The processor updates this field during a memory P-state change with the target state. See D18F2x94_dct[0][DphyMemPsSelEn] .
7:0	Reserved.

D18F2x9C_x0D0F_E00A_dct[0] Phy Dynamic Power Mode

Cold reset: 0000_0000h.

Bits	Description
31:5	Reserved.
4	Reserved.
3:0	Reserved.

D18F2x9C_x0D0F_E013_dct[0] Phy PLL Regulator Wait Time

Cold reset: 0000_0118h.

Bits	Description
31:16	Reserved.
15:0	PllRegWaitTime: PLL regulator wait time. Read-write. BIOS: 2.9.7.4 . 1=Specifies the number of 5 ns periods the phy waits for the PLL to become stable when coming out of PLL regulator off power down mode.

D18F2x9C_x0D0F_E019_dct[0] Fence2

Cold reset: 0000_0000h. BIOS: [2.9.7.4.3](#).

Bits	Description
31:15	Reserved.
14	Fence2EnableRxDll: phy fence2 enable receive DLL. Read-write. 1=Enable the use of Fence2ThresholdRxDll for DQS receiver enable second fence threshold. 0=Disable second fence. See D18F2x9C_x0000_000C_dct[0][FenceThresholdRxDll] for first fence.

13:10	Fence2ThresholdRxDll: phy fence2 threshold DQS receiver enable. Read-write. If Fence2EnableRxDll=1, this field specifies the fence delay threshold value used for DQS receiver enable. See Fence2ThresholdTxPad.										
9:5	Reserved.										
4	Fence2EnableTxPad: fence2 enable transmit pad. Read-write. 1=Enable the use of Fence2ThresholdTxPad for transmit pad second fence threshold. 0=Disable second fence. See D18F2x9C_x0000_000C_dct[0] [FenceThresholdTxPad] for first fence.										
3:0	Fence2ThresholdTxPad: phy fence2 threshold transmit pad. Read-write. If Fence2EnableTxPad=1, this field specifies the second fence delay threshold value used for command, address, write data and write DQS. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0h</td><td>16/64 MEMCLK delay</td></tr> <tr> <td>1h</td><td>17/64 MEMCLK delay</td></tr> <tr> <td>Eh-2h</td><td>{1,<Fence2ThresholdTxPad>}/64 MEMCLK delay</td></tr> <tr> <td>Fh</td><td>31/64 MEMCLK delay</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0h	16/64 MEMCLK delay	1h	17/64 MEMCLK delay	Eh-2h	{1,<Fence2ThresholdTxPad>}/64 MEMCLK delay	Fh	31/64 MEMCLK delay
<u>Bits</u>	<u>Definition</u>										
0h	16/64 MEMCLK delay										
1h	17/64 MEMCLK delay										
Eh-2h	{1,<Fence2ThresholdTxPad>}/64 MEMCLK delay										
Fh	31/64 MEMCLK delay										

D18F2x9C_x0D0F_E01A_dct[0] M1 Fence Value

Cold reset: 0000_0000h. BIOS: [2.9.7.4.3](#). This register is used by BIOS to temporarily store the trained fence values for the M1 memory P-state, and has no effect on the operation of the hardware. See [2.9.7.4.3](#).

Bits	Description
31:16	Reserved.
15	Reserved.
14:10	TxDll: Transmit dll fence value. Read-write. BIOS saves the trained TxDll to this field until such time as it is able to write the value to NVRAM.
9:5	RxDll: Receiver dll fence value. Read-write. BIOS saves the trained RxDll to this field until such time as it is able to write the value to NVRAM.
4:0	TxPad: Transmit pad fence value. Read-write. BIOS saves the trained TxPad to this field until such time as it is able to write the value to NVRAM.

D18F2xA4 DRAM Controller Temperature Throttle

See [2.9.3 \[DCT Configuration Registers\]](#).

See [2.9.12 \[DRAM On DIMM Thermal Management and Power Capping\]](#).

Bits	Description																																		
31:24	Reserved.																																		
23:20	<p>BwCapCmdThrottleMode: bandwidth capping command throttle mode. Read-write. Reset: 0. Specifies the command throttle mode when BwCapEn=1. The DCT throttles commands over a rolling window of 100 clock cycles, maintaining the average throttling as specified by this field.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr><td>0000b</td><td>Command throttling is disabled</td></tr> <tr><td>0001b</td><td>Throttle commands by 30%</td></tr> <tr><td>0010b</td><td>Throttle commands by 40%</td></tr> <tr><td>0011b</td><td>Throttle commands by 50%</td></tr> <tr><td>0100b</td><td>Throttle commands by 55%</td></tr> <tr><td>0101b</td><td>Throttle commands by 60%</td></tr> <tr><td>0110b</td><td>Throttle commands by 65%</td></tr> <tr><td>0111b</td><td>Throttle commands by 70%</td></tr> <tr><td>1000b</td><td>Throttle commands by 75%</td></tr> <tr><td>1001b</td><td>Throttle commands by 80%</td></tr> <tr><td>1010b</td><td>Throttle commands by 85%</td></tr> <tr><td>1011b</td><td>Throttle commands by 90%</td></tr> <tr><td>1100b</td><td>Throttle commands by 95%</td></tr> <tr><td>1101b</td><td>Reserved</td></tr> <tr><td>1110b</td><td>Throttle commands as specified by CmdThrottleMode</td></tr> <tr><td>1111b</td><td>Reserved</td></tr> </table> <p>Throttling should not be enabled until after DRAM initialization (D18F2x110[DramEnable]=1) and training (see 2.9.7.9 [DRAM Training]) are complete.</p>	<u>Bits</u>	<u>Description</u>	0000b	Command throttling is disabled	0001b	Throttle commands by 30%	0010b	Throttle commands by 40%	0011b	Throttle commands by 50%	0100b	Throttle commands by 55%	0101b	Throttle commands by 60%	0110b	Throttle commands by 65%	0111b	Throttle commands by 70%	1000b	Throttle commands by 75%	1001b	Throttle commands by 80%	1010b	Throttle commands by 85%	1011b	Throttle commands by 90%	1100b	Throttle commands by 95%	1101b	Reserved	1110b	Throttle commands as specified by CmdThrottleMode	1111b	Reserved
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15	Reserved.																																		

14:12	<p>CmdThrottleMode: command throttle mode. Read-write. Reset: 0. BIOS: See 2.9.7.7 [DCT Training Specific Configuration]. Specifies the command throttle mode when ODTSEn=1 and the EVENT_L pin is asserted. The DCT throttles commands over a rolling window of 100 clock cycles, maintaining the average throttling as specified by this field.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Command throttling is disabled.</td></tr> <tr> <td>001b</td><td>Throttle commands by 30%.</td></tr> <tr> <td>010b</td><td>Throttle commands by 50%.</td></tr> <tr> <td>011b</td><td>Throttle commands by 60%.</td></tr> <tr> <td>100b</td><td>Throttle commands by 70%.</td></tr> <tr> <td>101b</td><td>Throttle commands by 80%.</td></tr> <tr> <td>110b</td><td>Throttle commands by 90%.</td></tr> <tr> <td>111b</td><td>Place the DRAM devices in powerdown mode (see D18F2x94_dct[0][PowerDownMode]) when EVENT_L is asserted. This mode is not valid if D18F2x94_dct[0][PowerDownEn]=0.</td></tr> </table> <p>Throttling should not be enabled until after DRAM initialization (D18F2x110[DrainEnable]=1) and training are complete. See also BwCapEn.</p>	Bits	Description	000b	Command throttling is disabled.	001b	Throttle commands by 30%.	010b	Throttle commands by 50%.	011b	Throttle commands by 60%.	100b	Throttle commands by 70%.	101b	Throttle commands by 80%.	110b	Throttle commands by 90%.	111b	Place the DRAM devices in powerdown mode (see D18F2x94_dct[0][PowerDownMode]) when EVENT_L is asserted. This mode is not valid if D18F2x94_dct[0][PowerDownEn] =0.
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111b	Place the DRAM devices in powerdown mode (see D18F2x94_dct[0][PowerDownMode]) when EVENT_L is asserted. This mode is not valid if D18F2x94_dct[0][PowerDownEn] =0.																		
11	<p>BwCapEn: bandwidth capping enable. Read-write. Reset: 0. 1=The memory command throttle mode specified by BwCapCmdThrottleMode is applied.</p> <p>This bit is used by software to enable command throttling independent of the state of the EVENT_L pin. If this bit is set, ODTSEn=1, and the EVENT_L pin is asserted, the larger of the two throttle percentages specified by CmdThrottleMode and BwCapCmdThrottleMode is used.</p>																		
10:9	Reserved.																		
8	<p>ODTSEn: on DIMM temperature sensor enable. Read-write. Reset: 0.</p> <p>BIOS: See 2.9.7.7 [DCT Training Specific Configuration].</p> <p>Enables the monitoring of the EVENT_L pin and indicates whether the on DIMM temperature sensors of the DIMMs on a channel are enabled. 0=Disabled. 1=Enabled. While the EVENT_L pin is asserted, the controller (a) doubles the refresh rate (if $T_{ref}=7.8\text{ us}$), and (b) throttles the address bus utilization as specified by CmdThrottleMode[2:0].</p>																		
7:0	Reserved.																		

D18F2xA8_dct[0] DRAM Controller Miscellaneous 2

See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description
31	<p>PerRankTimingEn: per rank timing enable. Read-write. Reset: 0. BIOS: ~DlIPDBypassMode.</p> <p>Specifies the mapping between chip selects and a set of programmable timing delays. 1=Each chip select is controlled by a set of timing delays. A maximum of 4 chip selects are supported per channel. 0=Each chip select pair is controlled by a set timing delays.</p>
30	Reserved.
29	Reserved.

28	FastSelfRefEntryDis: fast self refresh entry disable. Read-write; Same-for-all. Reset: 1. BIOS: ~D18F2x1B4[FlushWrOnS3StpGnt]. 1=DCT pushes outstanding transactions to memory prior to entering self refresh. 0=DCT enters self refresh immediately unless instructed to push outstanding transactions to memory by D18F2x11C[FlushWrOnStpGnt] or D18F2x1B4[FlushWrOnS3StpGnt].										
27:26	Reserved.										
25:24	Reserved.										
23	Reserved.										
22	PrtlChPDEnhEn: partial channel power down enh enable. Read-write. Reset: 0. BIOS: 0. Selects the channel idle hysteresis for fast exit/slow exit mode changes when (D18F2x94_dct[0][Power-DownMode] & D18F2x84_dct[0][PchgPDMoSel]). 1=Hysteresis specified by D18F2x244_dct[0][PrtlChPDDynDly]. 0=256 clock hysteresis.										
21	AggrPDEn: aggressive power down enable. Read-write. Reset: 0. BIOS: 1. 1=The DCT places the DRAM devices in precharge power down mode when pages are closed as specified by D18F2x248_dct[0]_mp[1:0][AggrPDDelay]. 0=The DCT places the DRAM devices in precharge power down mode when pages are closed as specified by D18F2x90_dct[0][DynPageCloseEn].										
20	BankSwap: swap bank address. Read-write. Reset: 0. BIOS: See 2.9.7.7. 1=Swap the DRAM bank address bits. The normalized address bits used for bank address are swapped with lower order address bits. If D18F2x114[DctSelBankSwap]==1 then normalized address bits 10:8 are swapped else normalized address bits 11:9 are swapped. See D18F2x80_dct[0]. This swap happens before D18F2x94_dct[0][BankSwizzleMode] is applied.										
19	Reserved.										
18	Reserved.										
17:16	MemPhyPllPdMode: memory phy PLL powerdown mode. Read-write. Reset: 00b. BIOS: 10b. These bits control how the memory PLL powers down during self-refresh. If self-refresh is requested for an NB p-state change, then the memory PLL is not powered down. Memory phy PLL powerdown can only be enabled if NB PLL power down is enabled. See D18F5x128[NbPllPwrDwnRegEn]. <table border="1"> <thead> <tr> <th>Bits</th><th>Description</th></tr> </thead> <tbody> <tr> <td>00b</td><td>PLL powerdown is disabled</td></tr> <tr> <td>01b</td><td>PLL VCO powerdown during SR</td></tr> <tr> <td>10b</td><td>PLL regulator powerdown during SR</td></tr> <tr> <td>11b</td><td>PLL VCO and regulator powerdown during SR</td></tr> </tbody> </table>	Bits	Description	00b	PLL powerdown is disabled	01b	PLL VCO powerdown during SR	10b	PLL regulator powerdown during SR	11b	PLL VCO and regulator powerdown during SR
Bits	Description										
00b	PLL powerdown is disabled										
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10b	PLL regulator powerdown during SR										
11b	PLL VCO and regulator powerdown during SR										
15:8	Reserved.										
7:6	Reserved.										
5	Reserved.										
4	Reserved.										
3:2	Reserved.										
1:0	Reserved.										

D18F2xAC DRAM Controller Temperature Status

Cold reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:4	Reserved.

3:2	Reserved.
1	Reserved.
0	MemTempHot0: Memory temperature hot, DCT0. Read; Write-1-to-clear. 1=The EVENT_L pin was asserted indicating the memory temperature exceeded the normal operating limit; the DCT may be throttling the interface to aid in cooling. See D18F2xA4 .

D18F2xF8 P-state Power Information 1

Read-only.

Bits	Description										
31:24	PwrValue3: P3 power value. See PwrValue0. Value: Product-specific.										
23:16	PwrValue2: P2 power value. See PwrValue0. Value: Product-specific.										
15:8	PwrValue1: P1 power value. See PwrValue0. Value: Product-specific.										
7:0	PwrValue0: P0 power value. PwrValue and PwrDiv together specify the expected power draw of a single core in P0 and 1/NumCores of the Northbridge in the NB P-state as specified by MSRC001_00[6B:64][NbPstate] . NumCores is defined to be the number of cores per node at cold reset. Value: Product-specific. <table> <tr> <th><u>PwrDiv</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>PwrValue / 1 W, Range: 0 to 255 W</td></tr> <tr> <td>01b</td><td>PwrValue / 10 W, Range: 0 to 25.5 W</td></tr> <tr> <td>10b</td><td>PwrValue / 100 W, Range: 0 to 2.55 W</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>PwrDiv</u>	<u>Description</u>	00b	PwrValue / 1 W, Range: 0 to 255 W	01b	PwrValue / 10 W, Range: 0 to 25.5 W	10b	PwrValue / 100 W, Range: 0 to 2.55 W	11b	Reserved
<u>PwrDiv</u>	<u>Description</u>										
00b	PwrValue / 1 W, Range: 0 to 255 W										
01b	PwrValue / 10 W, Range: 0 to 25.5 W										
10b	PwrValue / 100 W, Range: 0 to 2.55 W										
11b	Reserved										

D18F2xFC P-state Power Information 2

Read-only.

Bits	Description
31:24	Reserved.
23:22	PwrDiv7: P7 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
21:20	PwrDiv6: P6 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
19:18	PwrDiv5: P5 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
17:16	PwrDiv4: P4 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
15:14	PwrDiv3: P3 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
13:12	PwrDiv2: P2 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
11:10	PwrDiv1: P1 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
9:8	PwrDiv0: P0 power divisor. See D18F2xF8[PwrValue0] . Value: Product-specific.
7:0	PwrValue4: P4 power value. See D18F2xF8[PwrValue0] . Value: Product-specific.

D18F2x104 P-state Power Information 3

Read-only.

Bits	Description
31:24	Reserved.
23:16	PwrValue7: P7 power value. See D18F2xF8[PwrValue0] . Value: Product-specific.
15:8	PwrValue6: P6 power value. See D18F2xF8[PwrValue0] . Value: Product-specific.
7:0	PwrValue5: P5 power value. See D18F2xF8[PwrValue0] . Value: Product-specific.

D18F2x110 DRAM Controller Select Low

Reset: 0000_0000h.

Bits	Description
31:11	Reserved.
10	MemCleared: memory cleared. Read-only; updated-by-hardware. 1=Memory has been cleared since the last warm reset. This bit is set by MemClrInit. See MemClrInit.
9	MemClrBusy: memory clear busy. Read-only; updated-by-hardware. 1=The memory clear operation in either of the DCTs is in progress. Reads or writes to DRAM while the memory clear operation is in progress result in undefined behavior.
8	DramEnable: DRAM enabled. Read-only. 1=All of the used DCTs are initialized (see 2.9.7.8 [DRAM Device and Controller Initialization]) or have exited from self refresh (D18F2x90_dct[0][ExitSelfRef] transitions from 1 to 0).
7:6	Reserved.
5	DctDatIntLv: DRAM controller data interleave enable. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. BIOS: D18F3x44[DramEccEn] . 1=DRAM data bits from every two consecutive 64-bit DRAM lines are interleaved in the ECC calculation such that a dead bit of a DRAM device is correctable.
4	Reserved.
3	MemClrInit: memory clear initialization. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 1=The node writes 0's to all locations of system memory attached to the node and sets the MemCleared bit. The status of the memory clear operation can be determined by reading the MemClrBusy and MemCleared bits. This command is ignored if MemClrBusy=1 when the command is received. DramEnable must be set before setting MemClrInit. The memory prefetcher must be disabled by setting D18F2x11C[PrefIoDis] and D18F2x11C[PrefCpuDis] before memory clear initialization and then can be re-enabled when MemCleared=1. Memory hole remapping must be disabled before setting MemClrInit. See D18F1x2[1,0][8,0][LgcyMmioHoleEn] . Software may then reenable memory hole remapping when the memory clear is complete.
2:0	Reserved.

D18F2x114 DRAM Controller Select High

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000_0000h.

Bits	Description
31:10	Reserved.

9	DctSelBankSwap: select DRAM bank swap address. BIOS: 1. See D18F2xA8_dct[0][BankSwap] .
8:0	Reserved.

D18F2x118 Memory Controller Configuration Low

Fields in this register (bits[17:0]) indicate priority of request types. Variable priority requests enter the memory controller as medium priority and are promoted to high priority if they have not been serviced in the time specified by MctVarPriCntLmt. This feature may be useful for isochronous IO traffic. If isochronous traffic is specified to be high priority, it may have an adverse effect on the bandwidth and performance of the devices associated with the other types of traffic. However, if isochronous traffic is specified as medium priority, the processor may not meet the isochronous bandwidth and latency requirements. The variable priority allows the memory controller to optimize DRAM transactions until isochronous traffic reaches a time threshold and must be serviced more quickly.

Bits	Description			
31:28	MctVarPriCntLmt: variable priority time limit. Read-write. Reset: 0000b. BIOS: 0001b.			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	0000b	80ns	1000b	720ns
	0001b	160ns	1001b	800ns
	0010b	240ns	1010b	880ns
	0011b	320ns	1011b	960ns
	0100b	400ns	1100b	1040ns
	0101b	480ns	1101b	1120ns
	0110b	560ns	1110b	1200ns
0111b	640ns	1111b	1280ns	
27	Reserved.			
26:24	McqHiPriByPassMax: memory controller high priority bypass max. Read-write. Reset: 100b. Specifies the number high-priority operations that are allowed before yielding to medium or low-priority operations. 000b is reserved.			
23	Reserved.			
22:20	McqMedPriByPassMax: memory controller medium bypass low priority max. Read-write. Reset: 100b. Specifies the number of medium-priority operations that are allowed before yielding to low-priority operations. 000b is reserved.			

19	<p>LockDramCfg. Write-1-only. Reset: 0. BIOS: See 2.9.11 [DRAM CC6/PC6 Storage], 2.5.3.2.3.3 [Core C6 (CC6) State].</p> <p>The following registers are read-only if LockDramCfg=1; otherwise the access type is specified by the register:</p> <ul style="list-style-type: none"> • D18F1xF0 [DRAM Hole Address] • D18F2x[5C:40]_dct[0] [DRAM CS Base Address] • D18F2x[6C:60]_dct[0] [DRAM CS Mask] • D18F2x80_dct[0] [DRAM Bank Address Mapping] • D18F2x110 [DRAM Controller Select Low] • D18F2x114 [DRAM Controller Select High] • D18F2x250_dct[0] [DRAM Loopback and Training Control] • D18F4x128[CoreStateSaveDestNode] • D18F1x[17C:140,7C:40] [DRAM Base/Limit] • D18F1x120 [DRAM Base System Address] • D18F1x124 [DRAM Limit System Address] • D18F2x118[CC6SaveEn] 										
18	<p>CC6SaveEn. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=CC6 save area is enabled. See 2.5.3.2.7 [BIOS Requirements for Initialization]. BIOS: (D18F4x118[PwrGateEnCstAct0] D18F4x118[PwrGateEnCstAct1] D18F4x11C[PwrGateEnCstAct2]).</p>										
17:16	<p>MctPriScrub: scrubber priority. Read-write. Reset: 00b.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Medium</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>High</td></tr> <tr> <td>11b</td><td>Variable</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	Medium	01b	Reserved	10b	High	11b	Variable
<u>Bits</u>	<u>Description</u>										
00b	Medium										
01b	Reserved										
10b	High										
11b	Variable										
15:14	<p>MctPriTrace: trace-mode request priority. See: MctPriCpuRd. Read-write. Reset: 10b. This must be set to high.</p>										
13:12	<p>MctPriIloc: display refresh read priority. See: MctPriCpuRd. Read-write. Reset: 10b.</p>										
11:10	<p>MctPriWr: default write priority. See: MctPriCpuRd. Read-write. Reset: 01b.</p>										
9:8	<p>MctPriDefault: default non-write priority. See: MctPriCpuRd. Read-write. Reset: 00b.</p>										
7:6	<p>MctPriIlocWr: IO write with the isoch bit set priority. See: MctPriCpuRd. Read-write. Reset: 00b. This does not apply to isochronous traffic that is classified as display refresh.</p>										
5:4	<p>MctPriIlocRd: IO read with the isoch bit set priority. See: MctPriCpuRd. Read-write. Reset: 10b. This does not apply to isochronous traffic that is classified as display refresh.</p>										
3:2	<p>MctPriCpuWr: CPU write priority. See: MctPriCpuRd. Read-write. Reset: 01b.</p>										
1:0	<p>MctPriCpuRd: CPU read priority. Read-write. Reset: 00b.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Medium</td></tr> <tr> <td>01b</td><td>Low</td></tr> <tr> <td>10b</td><td>High</td></tr> <tr> <td>11b</td><td>Variable</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	Medium	01b	Low	10b	High	11b	Variable
<u>Bits</u>	<u>Description</u>										
00b	Medium										
01b	Low										
10b	High										
11b	Variable										

D18F2x11C Memory Controller Configuration High

The two main functions of this register are to control write bursting and memory prefetching.

Write bursting. DctWrLimit and MctWrLimit specify how writes may be burst from the MCT into the DCT to improve DRAM efficiency. When the number of writes in the MCT reaches the value specified in MctWrLimit, then they are all burst to the DCTs at once. Prior to reaching the watermark, a limited number of writes can be passed to the DCTs (specified by DctWrLimit), tagged as low priority, for the DCTs to complete when otherwise idle. Rules regarding write bursting:

- Write bursting mode only applies to low-priority writes. Medium and high priority writes are not withheld from the DCTs for write bursting.
- If write bursting is enabled, writes stay in the MCQ until the threshold specified by MctWrLimit is reached.
- Once the threshold is reached, all writes in MCQ are converted to medium priority.
- Any write in MCQ that matches the address of a subsequent access is promoted to either medium priority or the priority of the subsequent access, whichever is higher.
- DctWrLimit only applies to low-priority writes.

Memory prefetching. The MCT prefetcher detects stride patterns in the stream of requests and then, for predictable stride patterns, generates prefetch requests. A stride pattern is a pattern of requests through system memory that are the same number of cachelines apart. The prefetcher supports strides of -4 to +4 cachelines, which can include alternating patterns (e.g. +1, +2, +1, +2), and can prefetch 1, 2, 3, 4, or 5 cachelines ahead, depending on the confidence. In addition, a fixed stride mode (non-alternating) may be used for IO requests which often have fixed stride patterns. This mode bypasses the stride predictor such that CPU-access stride predictions are not adversely affected by IO streams.

The MCT tracks several stride patterns simultaneously. Each of these has a confidence level associated with it that varies as follows:

- Each time a request is received that matches the stride pattern, the confidence level increases by one.
- Each time a request is received within +/- 4 cachelines of the last requested cacheline in the pattern that does not match the pattern, then the confidence level decreases by one.
- When the confidence level reaches the saturation point specified by PrefConfSat, then it no-longer increments.

Each request that is not within +/- 4 cachelines of the last requested cacheline line of all the stride patterns tracked initiates a new stride pattern by displacing one of the existing least-recently-used stride patterns.

The memory prefetcher uses an adaptive prefetch scheme to adjust the prefetch distance based upon the buffer space available for prefetch request data. The adaptive scheme counts the total number of prefetch requests and the number of prefetch requests that cannot return data because of buffer availability. After every 16 prefetch requests, the prefetcher uses the following rules to adjust the prefetch distance:

- If the ratio of prefetch requests that cannot return data to total prefetch requests is greater than or equal to `D18F2x1B0[AdapPrefMissRatio]` then the prefetch distance is reduced by `D18F2x1B0[AdapPrefNegativeStep]`.
- If the ratio of prefetch requests that cannot return data to total prefetch requests is less than `D18F2x1B0[AdapPrefMissRatio]` then the prefetch distance is increased by `D18F2x1B0[AdapPrefPositiveStep]`.
- If the adjusted prefetch distance is greater than the prefetch distance defined for the current confidence level, the prefetch distance for the current confidence level is used.

The adaptive prefetch scheme supports fractional prefetch distances by alternating between two whole number prefetch distances. For example a prefetch distance of 1.25 causes a prefetch distance sequence of: 1, 1, 1, 2, 1, 1, 1, 2.

Bits	Description										
31	MctScrubEn: MCT scrub enable. Read-write. Reset: 0. 1=Enables periodic flushing of prefetches and writes based on the DRAM scrub rate. This is used to ensure that prefetch and write data aging is not so long that soft errors accumulate and become uncorrectable. When enabled, each DRAM scrub event causes a single prefetch to be de-allocated (the oldest one) and all queued writes to be flushed to DRAM.										
30	FlushWr: flush writes command. Read; write-1-only; cleared-by-hardware. Reset: 0. Setting this bit causes write bursting to be canceled and all outstanding writes to be flushed to DRAM. This bit is cleared when all writes are flushed to DRAM.										
29	FlushWrOnStpGnt: flush writes on stop-grant. Read-write. Reset: 0. BIOS: ~D18F2x1B4[FlushWrOnS3StpGnt]. 1=Causes write bursting to be canceled and all outstanding writes to be flushed to DRAM when in the stop-grant state.										
28	Reserved.										
27:25	PrefThreeConf: prefetch three-ahead confidence. Read-write. Reset: 100b. BIOS: 110b. Confidence level required in order to prefetch three cachelines ahead (same encoding as PrefTwoConf below).										
24:22	PrefTwoConf: prefetch two-ahead confidence. Read-write. Reset: 011b. BIOS: 011b. Confidence level required in order to prefetch two cachelines ahead. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefTwoConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>	Bits	Description	000b	0	110b-001b	[PrefTwoConf*2]	111b	14		
Bits	Description										
000b	0										
110b-001b	[PrefTwoConf*2]										
111b	14										
21:20	PrefOneConf: prefetch one-ahead confidence. Read-write. Reset: 10b. BIOS: 10b. Confidence level required in order to prefetch one ahead (0 through 3).										
19:18	PrefConfSat: prefetch confidence saturation. Read-write. Reset: 00b. BIOS: 00b. Specifies the point at which prefetch confidence level saturates and stops incrementing. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>15</td></tr> <tr> <td>01b</td><td>7</td></tr> <tr> <td>10b</td><td>3</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	15	01b	7	10b	3	11b	Reserved
Bits	Description										
00b	15										
01b	7										
10b	3										
11b	Reserved										
17:16	PrefFixDist: prefetch fixed stride distance. Read-write. Reset: 00b. Specifies the distance to prefetch ahead if in fixed stride mode. 00b=1 cacheline; 01b=2 cachelines; 10b=3 cachelines; 11b=4 cachelines.										
15	PrefFixStrideEn: prefetch fixed stride enable. Read-write. Reset: 0. 1=The prefetch stride for all requests (CPU and IO) is fixed (non-alternating).										
14	PrefIoFixStrideEn: Prefetch IO fixed stride enable. Read-write. Reset: 0. 1=The prefetch stride for IO requests is fixed (non-alternating).										
13	PrefIoDis: prefetch IO-access disable. Read-write. Reset: 1. BIOS: 0. 1=Disables IO requests from triggering prefetch requests.										
12	PrefCpuDis: prefetch CPU-access disable. Read-write. Reset: 1. BIOS: 0. 1=Disables CPU requests from triggering prefetch requests.										
11:7	MctPrefReqLimit: memory controller prefetch request limit. Read-write. Reset: 1Eh. Specifies the maximum number of outstanding prefetch requests allowed. See D18F3x78 for restrictions on this field.										

6:2	MctWrLimit: memory controller write-burst limit. Read-write. Reset: 1Fh. BIOS: 0Ch. Specifies the number of writes in the memory controller queue before they are burst into the DCTs. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>32</td></tr> <tr> <td>1Dh-01h</td><td>[32-MctWrLimit]</td></tr> <tr> <td>1Eh</td><td>2</td></tr> <tr> <td>1Fh</td><td>Write bursting disabled</td></tr> </table>	Bits	Description	00h	32	1Dh-01h	[32-MctWrLimit]	1Eh	2	1Fh	Write bursting disabled
Bits	Description										
00h	32										
1Dh-01h	[32-MctWrLimit]										
1Eh	2										
1Fh	Write bursting disabled										
1:0	DctWrLimit: DRAM controller write limit. Read-write. Reset: 00b. BIOS: 00b. Specifies the maximum number of writes allowed in the DCT queue when write bursting is enabled, prior to when the number of writes in MCQ exceeds the watermark specified by MctWrLimit. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>0</td></tr> <tr> <td>01b</td><td>2</td></tr> <tr> <td>10b</td><td>4</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	0	01b	2	10b	4	11b	Reserved
Bits	Description										
00b	0										
01b	2										
10b	4										
11b	Reserved										

D18F2x1B0 Extended Memory Controller Configuration Low

The main function of this register is to control the memory prefetcher. See [D18F2x11C \[Memory Controller Configuration High\]](#) about the adaptive prefetch scheme.

Table 176: BIOS Recommendations for D18F2x1B[4:0]

Condition	D18F2x1B0	D18F2x1B4	
DdrRate	DcqBwThrotWm	DcqBwThrotWm1	DcqBwThrotWm2
667	0h	3h	4h
800	0h	3h	5h
1066	0h	4h	6h
1333	0h	5h	8h
1600	0h	6h	9h
1866	0h	7h	Ah
2133	0h	8h	Ch

Bits	Description								
31:28	DcqBwThrotWm: dcq bandwidth throttle watermark. Read-write. Reset: 3h. BIOS: Table 176 . Specifies the number of outstanding DRAM read requests before new DRAM prefetch requests and speculative prefetch requests are throttled. 0h=Throttling is disabled. Legal values are 0h through Ch. Programming this field to a non-zero value disables D18F2x1B4 [DcqBwThrotWm1, DcqBwThrotWm2].								
27:25	PrefFiveConf: prefetch five-ahead confidence. Read-write. Reset: 110b. BIOS: 111b. Confidence level required in order to prefetch five cachelines ahead. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefFiveConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>	Bits	Description	000b	0	110b-001b	[PrefFiveConf*2]	111b	14
Bits	Description								
000b	0								
110b-001b	[PrefFiveConf*2]								
111b	14								

24:22	PrefFourConf: prefetch four-ahead confidence. Read-write. Reset: 101b. BIOS: 111b. Confidence level required in order to prefetch four cachelines ahead. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefFourConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>	Bits	Description	000b	0	110b-001b	[PrefFourConf*2]	111b	14		
Bits	Description										
000b	0										
110b-001b	[PrefFourConf*2]										
111b	14										
21	Reserved.										
20	DbIPrefEn: double prefetch enable. Read-write. Reset: 0. 1=The memory prefetcher only generates prefetch requests when it is able to generate a pair of prefetch requests to consecutive cache lines.										
19:18	Reserved.										
17:13	Reserved. Reset: 11100b.										
12	EnSplitDctLimits: split DCT write limits enable. Read-write. Reset: 0. BIOS: 1. 1=The number of writes specified by D18F2x11C [DctWrLimit, MctWrLimit] is per DCT. 0=The number of writes specified by D18F2x11C [DctWrLimit, MctWrLimit] is for the even[0,2] or odd[1,3] DCT channels. 0=The number of writes specified by D18F2x11C [DctWrLimit, MctWrLimit] is total writes independent of DCT. Setting this bit also affects the encoding of D18F2x11C [DctWrLimit].										
11	DisloCohPref: disable coherent prefetched for IO. Read-write. Reset: 0. 1=Probes are not generated for prefetches generated for reads from IO devices.										
10:8	CohPrefPrbLmt: coherent prefetch probe limit. Read-write. Reset: 000b. BIOS: 000b. Specifies the maximum number of probes that can be outstanding for memory prefetch requests. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Probing disabled for memory prefetch requests</td></tr> <tr> <td>111b-001b</td><td>Reserved.</td></tr> </table>	Bits	Description	000b	Probing disabled for memory prefetch requests	111b-001b	Reserved.				
Bits	Description										
000b	Probing disabled for memory prefetch requests										
111b-001b	Reserved.										
7:6	Reserved.										
5:4	AdapPrefNegativeStep: adaptive prefetch negative step. Read-write. Reset: 00b. BIOS: 00b. Specifies the step size that the adaptive prefetch scheme uses when decreasing the prefetch distance. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>2/16</td></tr> <tr> <td>01b</td><td>4/16</td></tr> <tr> <td>10b</td><td>8/16</td></tr> <tr> <td>11b</td><td>16/16</td></tr> </table>	Bits	Description	00b	2/16	01b	4/16	10b	8/16	11b	16/16
Bits	Description										
00b	2/16										
01b	4/16										
10b	8/16										
11b	16/16										
3:2	AdapPrefPositiveStep: adaptive prefetch positive step. Read-write. Reset: 00b. BIOS: 00b. Specifies the step size that the adaptive prefetch scheme uses when increasing the prefetch distance. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1/16</td></tr> <tr> <td>01b</td><td>2/16</td></tr> <tr> <td>10b</td><td>4/16</td></tr> <tr> <td>11b</td><td>8/16</td></tr> </table>	Bits	Description	00b	1/16	01b	2/16	10b	4/16	11b	8/16
Bits	Description										
00b	1/16										
01b	2/16										
10b	4/16										
11b	8/16										
1:0	AdapPrefMissRatio: adaptive prefetch miss ratio. Read-write. Reset: 00b. BIOS: 01b. Specifies the ratio of prefetch requests that do not have data buffer available to the total number of prefetch requests at which the adaptive prefetch scheme begins decreasing the prefetch distance. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1/16</td></tr> <tr> <td>01b</td><td>2/16</td></tr> <tr> <td>10b</td><td>4/16</td></tr> <tr> <td>11b</td><td>8/16</td></tr> </table>	Bits	Description	00b	1/16	01b	2/16	10b	4/16	11b	8/16
Bits	Description										
00b	1/16										
01b	2/16										
10b	4/16										
11b	8/16										

D18F2x1B4 Extended Memory Controller Configuration High Register

Bits	Description
31	FlushOnMmioWrEn: flush on mmio write enable. Read-write. Reset: 0. 1=Any CPU-sourced MMIO write that matches D18F1x[2CC:2A0,1CC:180,BC:80] causes the memory controller data buffers to be flushed to memory.
30:28	S3SmafId: S3 SMAF id. Read-write. Reset: 100b. SMAF encoding of D18F3x[84:80] corresponding to the ACPI S3 state when FlushWrOnS3StpGnt=1. Reserved when FlushWrOnS3StpGnt=0.
27	FlushWrOnS3StpGnt: flush write on S3 stop grant. Read-write. Reset: 0. BIOS: 1. 1=Write bursting is canceled and all outstanding writes are flushed to DRAM when in the stop-grant state and the SMAF code is equal to S3SmafId, indicating entry into the ACPI S3 state. See D18F2xA8_dct[0][FastSelfRefEntryDis] , D18F2x11C[FlushWrOnStpGnt] .
26	EnSplitMctDatBuffers: enable split MCT data buffers. Read-write. Reset: 0. BIOS: 1. 1=Enable resource allocation into the split buffer resources BIOS must program this bit before any DRAM memory accesses are issued from the processor.
25	SmuCfgLock: SMU configuration lock. Read-write; updated-by-hardware. Reset: 0. This field should never be cleared by software. The following registers are read-only if LockSmuCfg=1; otherwise the access type is specified by the register: <ul style="list-style-type: none"> • D18F4x15C [Core Performance Boost Control] • D18F5x12C [Clock Power/Timing Control 4] • D18F5x170 [Northbridge P-state Control] • D18F5x188 [Clock Power/Timing Control 5] D18F5x170 [Northbridge P-state Control]
24:23	Reserved.
22	SpecPrefDisWm1: speculative prefetch disable watermark 1. Read-write. Reset: 0. 0=Disable speculative prefetches at the DcqBwThrotWm2 limit. 1=Disable speculative prefetches at the DcqBwThrotWm1 limit. See also D18F2x1B0[SpecPrefDis] .
21	RegionAlloWm2: region prefetch allocate watermark 2. Read-write. Reset: 0. See DemandAlloWm2.
20	RegionPropWm2: region prefetch propagate watermark 2. Read-write. Reset: 0. See DemandPropWm2.
19	StrideAlloWm2: stride prefetch allocate watermark 2. Read-write. Reset: 1. See DemandAlloWm2.
18	StridePropWm2: stride prefetch propagate watermark 2. Read-write. Reset: 1. See DemandPropWm2.
17	DemandAlloWm2: demand request allocate watermark 2. Read-write. Reset: 1. Specifies the behavior from the DcqBwThrotWm1 limit to the DcqBwThrotWm2 limit. 0=Requests do not allocate a new entry. 1=Requests allocate a new entry; defined only if (DemandAlloWm1 & DemandPropWm2).
16	DemandPropWm2: demand request propagate watermark 2. Read-write. Reset: 1. Specifies the behavior from the DcqBwThrotWm1 limit to the DcqBwThrotWm2 limit. 0=Requests do not update existing entries. 1=Requests update existing entries; defined only if (DemandPropWm1=1).
15	RegionAlloWm1: region prefetch allocate watermark 1. Read-write. Reset: 0. See DemandAlloWm1.

14	RegionPropWm1: region prefetch propagate watermark 1. Read-write. Reset: 1. See DemandPropWm1.
13	StrideAlloWm1: stride prefetch allocate watermark 1. Read-write. Reset: 1. See DemandAlloWm1.
12	StridePropWm1: stride prefetch propagate watermark 1. Read-write. Reset: 1. See DemandPropWm1.
11	DemandAlloWm1: demand request allocate watermark 1. Read-write. Reset: 1. Specifies the behavior prior to the DcqBwThrotWm1 limit. 0=Requests do not allocate a new entry. 1=Requests allocate a new entry; defined only if (DemandPropWm1=1).
10	DemandPropWm1: demand request propagate watermark 1. Read-write. Reset: 1. Specifies the behavior prior to the DcqBwThrotWm1 limit. 0=Requests do not update existing entries. 1=Requests update existing entries.
9:5	DcqBwThrotWm2: DCQ bandwidth throttle watermark 2. Read-write. Reset: 06h. BIOS: Table 176 . Specifies a prefetch throttling watermark based on the number of outstanding DRAM read requests. This field is reserved when D18F2x1B0 [DcqBwThrotWm] != 0. When throttling is enabled, if the number of outstanding DRAM read requests exceeds DcqBwThrotWm2 both request allocate and propagate are blocked and new prefetches are disabled. When throttling is enabled, DcqBwThrotWm2 should be programmed to a value greater than DcqBwThrotWm1. 0h=Throttling is disabled. Legal values are 0h through 18h.
4:0	DcqBwThrotWm1: DCQ bandwidth throttle watermark 1. Read-write. Reset: 03h. BIOS: Table 176 . Specifies a prefetch throttling watermark based on the number of outstanding DRAM read requests. This field is reserved when D18F2x1B0 [DcqBwThrotWm] != 0. 0h=Throttling is disabled. Legal values are 0h through 18h.

D18F2x1BC_dct[0] DRAM CKE to CS Map

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

Table 177: Field Mapping for [D18F2x1BC_dct\[0\]](#)

Register	Bits			
	31:24	23:16	15:8	7:0
D18F2x1BC_dct[0]	CKE3	CKE2	CKE1	CKE0

Table 178: BIOS Recommendations for [D18F2x1BC_dct\[0\]](#)

Condition:		D18F2x1BC_dct[0]
Package	NumDimmSlots	
FT3	1, 2	08040201h
FP4	1, 2	0000AA55

Bits	Description
31:24	CSMapCKE: CS map CKE. See: D18F2x1BC_dct[0] [7:0].
23:16	CSMapCKE: CS map CKE. See: D18F2x1BC_dct[0] [7:0].

15:8	CSMapCKE: CS map CKE. See: D18F2x1BC_dct[0][7:0] .												
7:0	<p>CSMapCKE: CS map CKE. Read-write. BIOS: See Table 178 [BIOS Recommendations for D18F2x1BC_dct[0]]. Maps the CS to CKE relationship. 1=This CKE is associated with the listed chip select. 0=This CKE is not associated with the listed chip select. See also D18F2x9C_x0000_000C_dct[0][CKETri].</p> <p>Only 1 CKE may be assigned to a CS across D18F2x1BC_dct[0]. Only even CKEs may be assigned to even CSes. Only odd CKEs may be assigned to odd CSes.</p> <table> <tr> <th><u>Bit</u></th><th><u>Description</u></th></tr> <tr> <td>[0]</td><td>CS0</td></tr> <tr> <td>[1]</td><td>CS1</td></tr> <tr> <td>[2]</td><td>CS2</td></tr> <tr> <td>[3]</td><td>CS3</td></tr> <tr> <td>[7:4]</td><td>Reserved</td></tr> </table>	<u>Bit</u>	<u>Description</u>	[0]	CS0	[1]	CS1	[2]	CS2	[3]	CS3	[7:4]	Reserved
<u>Bit</u>	<u>Description</u>												
[0]	CS0												
[1]	CS1												
[2]	CS2												
[3]	CS3												
[7:4]	Reserved												

D18F2x200_dct[0]_mp[1:0] DDR3 DRAM Timing 0

Reset: 0F05_0505h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description								
31:30	Reserved.								
29:24	<p>Tras: row active strobe. Read-write. BIOS: See 2.9.7.5 [SPD ROM-Based Configuration]. Specifies the minimum time in memory clock cycles from an activate command to a precharge command, both to the same chip select bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>07h-00h</td><td>Reserved</td></tr> <tr> <td>2Ah-08h</td><td><Tras> clocks</td></tr> <tr> <td>3Fh-2Bh</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	07h-00h	Reserved	2Ah-08h	<Tras> clocks	3Fh-2Bh	Reserved
<u>Bits</u>	<u>Description</u>								
07h-00h	Reserved								
2Ah-08h	<Tras> clocks								
3Fh-2Bh	Reserved								
23:21	Reserved.								
20:16	<p>Trp: row precharge time. Read-write. BIOS: See 2.9.7.5 [SPD ROM-Based Configuration]. Specifies the minimum time in memory clock cycles from a precharge command to an activate command or auto refresh command, both to the same bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td><Trp> clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	04h-00h	Reserved	13h-05h	<Trp> clocks	1Fh-14h	Reserved
<u>Bits</u>	<u>Description</u>								
04h-00h	Reserved								
13h-05h	<Trp> clocks								
1Fh-14h	Reserved								
15:13	Reserved.								

12:8	<p>Trcd: RAS to CAS delay. Read-write. BIOS: See 2.9.7.5 [SPD ROM-Based Configuration]. Specifies the time in memory clock cycles from an activate command to a read/write command, both to the same bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td><Trcd> clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	04h-00h	Reserved	13h-05h	<Trcd> clocks	1Fh-14h	Reserved
<u>Bits</u>	<u>Description</u>								
04h-00h	Reserved								
13h-05h	<Trcd> clocks								
1Fh-14h	Reserved								
7:5	Reserved.								
4:0	<p>Tcl: CAS latency. Read-write. BIOS: See 2.9.7.5 [SPD ROM-Based Configuration]. Specifies the time in memory clock cycles from the CAS assertion for a read cycle until data return (from the perspective of the DRAM devices).</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td><Tcl> clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	04h-00h	Reserved	13h-05h	<Tcl> clocks	1Fh-14h	Reserved
<u>Bits</u>	<u>Description</u>								
04h-00h	Reserved								
13h-05h	<Tcl> clocks								
1Fh-14h	Reserved								

D18F2x204_dct[0]_mp[1:0] DDR3 DRAM Timing 1

Reset: 0400_040Bh. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description										
31:28	Reserved.										
27:24	<p>Trtp: read CAS to precharge time. Read-write. BIOS: See 2.9.7.5. Specifies the earliest time in memory clock cycles a page can be closed after having been read. Satisfying this parameter ensures read data is not lost due to a premature precharge.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>3h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-4h</td><td><Trtp> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	3h-0h	Reserved	Bh-4h	<Trtp> clocks	Fh-Ch	Reserved		
<u>Bits</u>	<u>Description</u>										
3h-0h	Reserved										
Bh-4h	<Trtp> clocks										
Fh-Ch	Reserved										
23:22	Reserved.										
21:16	<p>FourActWindow: four bank activate window. Read-write. BIOS: See 2.9.7.5. Specifies the rolling tFAW window in memory clock cycles during which no more than 4 banks in an 8-bank device are activated.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00h</td><td>No tFAW window restriction</td></tr> <tr> <td>05h-01h</td><td>Reserved</td></tr> <tr> <td>2Ch-06h</td><td>[FourActWindow] clocks</td></tr> <tr> <td>3Fh-2Dh</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00h	No tFAW window restriction	05h-01h	Reserved	2Ch-06h	[FourActWindow] clocks	3Fh-2Dh	Reserved
<u>Bits</u>	<u>Description</u>										
00h	No tFAW window restriction										
05h-01h	Reserved										
2Ch-06h	[FourActWindow] clocks										
3Fh-2Dh	Reserved										
15:12	Reserved.										
11:8	<p>Trrd: row to row delay (or RAS to RAS delay). Read-write. BIOS: See 2.9.7.5. Specifies the minimum time in memory clock cycles between activate commands to different chip select banks.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>9h-1h</td><td><Trrd> clocks</td></tr> <tr> <td>Fh-Ah</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	0h	Reserved	9h-1h	<Trrd> clocks	Fh-Ah	Reserved		
<u>Bits</u>	<u>Description</u>										
0h	Reserved										
9h-1h	<Trrd> clocks										
Fh-Ah	Reserved										

7:6	Reserved.								
5:0	<p>Trc: row cycle time. Read-write. BIOS: See 2.9.7.5. Specifies the minimum time in memory clock cycles from and activate command to another activate command or an auto refresh command, all to the same chip select bank.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>09h-00h</td><td>Reserved</td></tr> <tr> <td>3Ah-0Ah</td><td><Trc> clocks</td></tr> <tr> <td>3Fh-3Bh</td><td>Reserved</td></tr> </table>	Bits	Description	09h-00h	Reserved	3Ah-0Ah	<Trc> clocks	3Fh-3Bh	Reserved
Bits	Description								
09h-00h	Reserved								
3Ah-0Ah	<Trc> clocks								
3Fh-3Bh	Reserved								

D18F2x208_dct[0] DDR3 DRAM Timing 2

See 2.9.3 [DCT Configuration Registers].

Bits	Description																
31:27	Reserved.																
26:24	Trfc3: auto refresh row cycle time for CS 6 and 7. See: Trfc0.																
23:19	Reserved.																
18:16	Trfc2: auto refresh row cycle time for CS 4 and 5. See: Trfc0.																
15:11	Reserved.																
10:8	Trfc1: auto refresh row cycle time for CS 2 and 3. See: Trfc0.																
7:3	Reserved.																
2:0	<p>Trfc0: auto refresh row cycle time for CS 0 and 1. Read-write. Reset: 100b. BIOS: 2.9.7.5. Specifies the minimum time from a refresh command to the next valid command, except NOP or DES. The recommended programming of this register varies based on DRAM density and speed.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Reserved</td></tr> <tr> <td>001b</td><td>90 ns</td></tr> <tr> <td>010b</td><td>110 ns</td></tr> <tr> <td>011b</td><td>160 ns</td></tr> <tr> <td>100b</td><td>300 ns</td></tr> <tr> <td>101b</td><td>350 ns</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	Reserved	001b	90 ns	010b	110 ns	011b	160 ns	100b	300 ns	101b	350 ns	111b-110b	Reserved
Bits	Description																
000b	Reserved																
001b	90 ns																
010b	110 ns																
011b	160 ns																
100b	300 ns																
101b	350 ns																
111b-110b	Reserved																

D18F2x20C_dct[0]_mp[1:0] DDR3 DRAM Timing 3

See 2.9.3 [DCT Configuration Registers].

Bits	Description										
31:18	Reserved.										
17:16	<p>WrDqDqsEarly: DQ and DQS write early. Read-write. Reset: 0. Specifies the DQ and DQS launch timing for write commands relative to the Tcwl MEMCLK.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>0 MEMCLK early</td></tr> <tr> <td>01b</td><td>0.5 MEMCLK early</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	0 MEMCLK early	01b	0.5 MEMCLK early	10b	Reserved	11b	Reserved
Bits	Description										
00b	0 MEMCLK early										
01b	0.5 MEMCLK early										
10b	Reserved										
11b	Reserved										
15:12	Reserved.										

11:8	Twtr: internal DRAM write to read command delay. Read-write. Reset: 4h. BIOS: See 2.9.7.5 . Specifies the minimum number of memory clock cycles from a write operation to a read operation, both to the same chip select. This is measured from the rising clock edge following last non-masked data strobe of the write to the rising clock edge of the next read command. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-4h</td><td><Twtr> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	3h-0h	Reserved	Bh-4h	<Twtr> clocks	Fh-Ch	Reserved
Bits	Description								
3h-0h	Reserved								
Bh-4h	<Twtr> clocks								
Fh-Ch	Reserved								
7:5	Reserved.								
4:0	Tcwl: CAS write latency. Read-write. Reset: 5h. BIOS: See 2.9.7.5 . Specifies the number of memory clock cycles from internal write command to first write data in at the DRAM. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>0Ah-05h</td><td><Tcwl> clocks</td></tr> <tr> <td>1Fh-0Bh</td><td>Reserved</td></tr> </table>	Bits	Description	04h-00h	Reserved	0Ah-05h	<Tcwl> clocks	1Fh-0Bh	Reserved
Bits	Description								
04h-00h	Reserved								
0Ah-05h	<Tcwl> clocks								
1Fh-0Bh	Reserved								

D18F2x210_dct[0]_nbp[3:0] DRAM NB P-state

See [2.9.3 \[DCT Configuration Registers\]](#). For D18F2x210_dct[0]_nbp[x], x=D18F1x10C[NbPsSel]; see D18F1x10C[NbPsSel].

Table 179: BIOS Recommendations for RdPtrInit

Condition		D18F2x210_dct[0]_nbp[3:0]
NBCOF >= DdrRate	DdrRate	RdPtrInit
0	-	0010b
1	667, 800, 1066, 1333, 1600	0110b
1	1866, 2133	0101b

Bits	Description								
31:22	MaxRdLatency: maximum read latency. Read-write. Reset: 000h. BIOS: See 2.9.7.9.6 [Calculating MaxRdLatency] . Specifies the maximum round-trip latency in the system from the processor to the DRAM devices and back. The DRAM controller uses this to help determine when the first two beats of incoming DRAM read data can be safely transferred to the NCLK domain. The time includes the asynchronous and synchronous latencies. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000h</td><td>0 NCLKs</td></tr> <tr> <td>3FEh-001h</td><td><MaxRdLatency> NCLKs</td></tr> <tr> <td>3FFh</td><td>1023 NCLKs</td></tr> </table>	Bits	Description	000h	0 NCLKs	3FEh-001h	<MaxRdLatency> NCLKs	3FFh	1023 NCLKs
Bits	Description								
000h	0 NCLKs								
3FEh-001h	<MaxRdLatency> NCLKs								
3FFh	1023 NCLKs								
21:19	Reserved.								

18:16	DataTxFifoWrDly: data transmit FIFO write delay. Read-write. Reset: 0. BIOS: 0h. Specifies the DCT to phy write data FIFO delay.																		
	<table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0 MEMCLK</td></tr> <tr> <td>001b</td><td>0.5 MEMCLK</td></tr> <tr> <td>010b</td><td>1.0 MEMCLK</td></tr> <tr> <td>011b</td><td>1.5 MEMCLKs</td></tr> <tr> <td>100b</td><td>2.0 MEMCLKs</td></tr> <tr> <td>101b</td><td>2.5 MEMCLKs</td></tr> <tr> <td>110b</td><td>3.0 MEMCLKs</td></tr> <tr> <td>111b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	0 MEMCLK	001b	0.5 MEMCLK	010b	1.0 MEMCLK	011b	1.5 MEMCLKs	100b	2.0 MEMCLKs	101b	2.5 MEMCLKs	110b	3.0 MEMCLKs	111b	Reserved
Bits	Description																		
000b	0 MEMCLK																		
001b	0.5 MEMCLK																		
010b	1.0 MEMCLK																		
011b	1.5 MEMCLKs																		
100b	2.0 MEMCLKs																		
101b	2.5 MEMCLKs																		
110b	3.0 MEMCLKs																		
111b	Reserved																		
15:4	Reserved.																		
3:0	RdPtrInit: read pointer initial value. Read-write. Reset: 6h. BIOS: Table 179 . There is a synchronization FIFO between the NB clock domain and memory clock domain. Each increment of this field positions the read pointer one half clock cycle closer to the write pointer thereby reducing the latency through the FIFO. BIOS must program this field for the current or target NB P-state prior to a frequency change or NB P-state change.																		
	<table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0001b-0000b</td><td>Reserved</td></tr> <tr> <td>0010b</td><td>3 MEMCLK</td></tr> <tr> <td>0011b</td><td>2.5 MEMCLK</td></tr> <tr> <td>0100b</td><td>2 MEMCLKs</td></tr> <tr> <td>0101b</td><td>1.5 MEMCLKs</td></tr> <tr> <td>0110b</td><td>1 MEMCLKs</td></tr> <tr> <td>1111b-0111b</td><td>Reserved</td></tr> </table>	Bits	Description	0001b-0000b	Reserved	0010b	3 MEMCLK	0011b	2.5 MEMCLK	0100b	2 MEMCLKs	0101b	1.5 MEMCLKs	0110b	1 MEMCLKs	1111b-0111b	Reserved		
Bits	Description																		
0001b-0000b	Reserved																		
0010b	3 MEMCLK																		
0011b	2.5 MEMCLK																		
0100b	2 MEMCLKs																		
0101b	1.5 MEMCLKs																		
0110b	1 MEMCLKs																		
1111b-0111b	Reserved																		

D18F2x214_dct[0]_mp[1:0] DDR3 DRAM Timing 4

Reset: 0001_0202h.

Bits	Description												
31:20	Reserved.												
19:16	TwrrwrSdSc: write to write timing same DIMM same chip select. Read-write. BIOS: See 2.9.7.6.2 [TwrrwrSdSc, TwrrwrSdDc, TwrrwrDd (Write to Write Timing)] . Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following write-burst operation.												
	<table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>1h</td><td>1 clock</td></tr> <tr> <td>Ah-2h</td><td><TwrrwrSdSc> clocks</td></tr> <tr> <td>Bh</td><td>11 clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Reserved	1h	1 clock	Ah-2h	<TwrrwrSdSc> clocks	Bh	11 clocks	Fh-Ch	Reserved
Bits	Description												
0h	Reserved												
1h	1 clock												
Ah-2h	<TwrrwrSdSc> clocks												
Bh	11 clocks												
Fh-Ch	Reserved												
15:12	Reserved.												
11:8	TwrrwrSdDc: write to write timing same DIMM different chip select. See: TwrrwrDd.												

7:4	Reserved.								
3:0	<p>TwrrrDd: write to write timing different DIMM. Read-write. BIOS: See 2.9.7.6.2 [TwrrrSdSc, TwrrrSdDc, TwrrrDd (Write to Write Timing)]. Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-2h</td><td><TwrrrDd> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	1h-0h	Reserved	Bh-2h	<TwrrrDd> clocks	Fh-Ch	Reserved
Bits	Description								
1h-0h	Reserved								
Bh-2h	<TwrrrDd> clocks								
Fh-Ch	Reserved								

D18F2x218_det[0]_mp[1:0] DDR3 DRAM Timing 5

Reset: 0103_0203h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description										
31:30	<p>TrdrdBan: read to read timing ban. Read-write. BIOS: 00b. Bans the traffic for the specified cases where the number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd.</td></tr> <tr> <td>01b</td><td>Ban Trdrd traffic at 2 MEMCLKs.</td></tr> <tr> <td>10b</td><td>Ban Trdrd traffic at 2 and 3 MEMCLKs.</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd.	01b	Ban Trdrd traffic at 2 MEMCLKs.	10b	Ban Trdrd traffic at 2 and 3 MEMCLKs.	11b	Reserved
Bits	Description										
00b	Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd.										
01b	Ban Trdrd traffic at 2 MEMCLKs.										
10b	Ban Trdrd traffic at 2 and 3 MEMCLKs.										
11b	Reserved										
29:28	Reserved.										
27:24	<p>TrdrdSdSc: read to read timing same DIMM same chip select. Read-write. BIOS: See 2.9.7.6.1 [TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Read to Read Timing)]. Specifies the minimum number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Bh-1h</td><td><TrdrdSdSc> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Reserved	Bh-1h	<TrdrdSdSc> clocks	Fh-Ch	Reserved		
Bits	Description										
0h	Reserved										
Bh-1h	<TrdrdSdSc> clocks										
Fh-Ch	Reserved										
23:20	Reserved.										
19:16	TrdrdSdDc: read to read timing same DIMM different chip select. See: TrdrdDd.										
15:12	Reserved.										
11:8	<p>Twrrd: write to read DIMM termination turnaround. Read-write. BIOS: See 2.9.7.6.3 [Twrrd (Write to Read DIMM Termination Turn-around)]. Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following read-burst operation, both to different chip selects.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Bh-1h</td><td><Twrrd> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Reserved	Bh-1h	<Twrrd> clocks	Fh-Ch	Reserved		
Bits	Description										
0h	Reserved										
Bh-1h	<Twrrd> clocks										
Fh-Ch	Reserved										

7:4	Reserved.								
3:0	<p>TrdrdDd: read to read timing different DIMM. Read-write. BIOS: See 2.9.7.6.1 [TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Read to Read Timing)]. Specifies the minimum number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-2h</td><td><TrdrdDd> clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	Bits	Description	1h-0h	Reserved	Bh-2h	<TrdrdDd> clocks	Fh-Ch	Reserved
Bits	Description								
1h-0h	Reserved								
Bh-2h	<TrdrdDd> clocks								
Fh-Ch	Reserved								

D18F2x21C_dct[0]_mp[1:0] DDR3 DRAM Timing 6

Reset: 0004_0300h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description								
31:21	Reserved.								
20:16	<p>TrwtWB: read to write turnaround for opportunistic write bursting. Read-write. BIOS: TrwtTO + 1. Specifies the minimum number of clock cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>02h-00h</td><td>Reserved</td></tr> <tr> <td>1Ch-03h</td><td><TrwtWB> clocks</td></tr> <tr> <td>1Fh-1Dh</td><td>Reserved</td></tr> </table>	Bits	Description	02h-00h	Reserved	1Ch-03h	<TrwtWB> clocks	1Fh-1Dh	Reserved
Bits	Description								
02h-00h	Reserved								
1Ch-03h	<TrwtWB> clocks								
1Fh-1Dh	Reserved								
15:13	Reserved.								
12:8	<p>TrwtTO: read to write turnaround. Read-write. BIOS: See 2.9.7.6.4 [TrwtTO (Read-to-Write Turnaround for Data, DQS Contention)]. Specifies the minimum number of clock cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>1Bh-02h</td><td><TrwtTO> clocks</td></tr> <tr> <td>1Fh-1Ch</td><td>Reserved</td></tr> </table>	Bits	Description	01h-00h	Reserved	1Bh-02h	<TrwtTO> clocks	1Fh-1Ch	Reserved
Bits	Description								
01h-00h	Reserved								
1Bh-02h	<TrwtTO> clocks								
1Fh-1Ch	Reserved								
7:0	Reserved.								

D18F2x220_dct[0] DDR3 DRAM Timing 7

Reset: 0000_0C04h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description
31:13	Reserved.

12:8	Tmod: mode register command delay. Read-write. BIOS: See 2.9.7.5 . Specifies the minimum time in memory clock cycles from an MRS command to another non-MRS command (excluding NOP and DES), all to the same chip select. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>14h-2h</td><td><Tmod> clocks</td></tr> <tr> <td>1Fh-15h</td><td>Reserved</td></tr> </table>	Bits	Description	1h-0h	Reserved	14h-2h	<Tmod> clocks	1Fh-15h	Reserved
Bits	Description								
1h-0h	Reserved								
14h-2h	<Tmod> clocks								
1Fh-15h	Reserved								
7:4	Reserved.								
3:0	Tmrd: mode register command cycle time. Read-write. BIOS: See 2.9.7.5 . Specifies the minimum time in memory clock cycles from an MRS command to another MRS command, all to the same chip select. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>8h-2h</td><td><Tmrd> clocks</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>	Bits	Description	1h-0h	Reserved	8h-2h	<Tmrd> clocks	Fh-9h	Reserved
Bits	Description								
1h-0h	Reserved								
8h-2h	<Tmrd> clocks								
Fh-9h	Reserved								

D18F2x224_dct[0] DDR3 DRAM Timing 8

Reset: 0000_0408h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description			
31:11	Reserved.			
10:8	Tzqcs: Zq short cal command delay. Read-write. BIOS: See 2.9.7.5 . Specifies the minimum time in memory clock cycles from a ZQCS command to any other command (excluding NOP and DES) on the channel.			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	000b	Reserved	100b	64 clocks
	001b	16 clocks	101b	80 clocks
	010b	32 clocks	110b	96 clocks
	011b	48 clocks	111b	Reserved
7:4	Reserved.			
3:0	Tzqoper: Zq long cal command delay. Read-write. BIOS: See 2.9.7.5 . Specifies the minimum time in memory clock cycles from a ZQCL command to any other command (excluding NOP and DES) on the channel.			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	0000b	Reserved	1000b	256 clocks
	0001b	32 clocks	1001b	288 clocks
	0010b	64 clocks	1010b	320 clocks
	0011b	96 clocks	1011b	352 clocks
	0100b	128 clocks	1100b	384 clocks
	0101b	160 clocks	1111b-1101b	Reserved
	0110b	192 clocks		
	0111b	224 clocks		

D18F2x228_dct[0] DDR3 DRAM Timing 9

See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description								
31:24	Reserved.								
23:16	Reserved.								
15:8	Tstag1: auto refresh stagger time for logical DIMM 1. See: Tstag0.								
7:0	Tstag0: auto refresh stagger time for logical DIMM 0. Read-write. Reset: 00h. BIOS: $\text{MAX}(\text{D18F2x204_dct}[0]_mp[1:0][\text{Trrd}], \text{CEIL}(\text{D18F2x204_dct}[0]_mp[1:0][\text{FourActWindow}]/4))$. Specifies the number of clocks between auto refresh commands to different ranks of a DIMM when $\text{D18F2x90_dct}[0][\text{StagRefEn}]=1$. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>0 clocks</td></tr> <tr> <td>FEh-01h</td><td><Tstag0> clocks</td></tr> <tr> <td>FFh</td><td>255 clocks</td></tr> </table>	Bits	Description	00h	0 clocks	FEh-01h	<Tstag0> clocks	FFh	255 clocks
Bits	Description								
00h	0 clocks								
FEh-01h	<Tstag0> clocks								
FFh	255 clocks								

D18F2x22C_dct[0]_mp[1:0] DDR3 DRAM Timing 10

Reset: 0000_000Ch. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description																												
31:24	Reserved.																												
23:13	Reserved.																												
12:8	Reserved.																												
7:5	Reserved.																												
4:0	Twr: write recovery. Read-write. BIOS: See 2.9.7.5 . Specifies the minimum time from the last data write until the chip select bank precharge. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>4h-0h</td><td>Reserved</td></tr> <tr> <td>8h-5h</td><td>8 to 5 clocks</td></tr> <tr> <td>9h</td><td>Reserved</td></tr> <tr> <td>Ah</td><td>10 clocks</td></tr> <tr> <td>Bh</td><td>Reserved</td></tr> <tr> <td>Ch</td><td>12 clocks</td></tr> <tr> <td>Dh</td><td>Reserved</td></tr> <tr> <td>Eh</td><td>14 clocks</td></tr> <tr> <td>Fh</td><td>Reserved</td></tr> <tr> <td>10h</td><td>16 clocks</td></tr> <tr> <td>11h</td><td>Reserved</td></tr> <tr> <td>12h</td><td>18 clocks</td></tr> <tr> <td>1Fh-13h</td><td>Reserved</td></tr> </table>	Bits	Description	4h-0h	Reserved	8h-5h	8 to 5 clocks	9h	Reserved	Ah	10 clocks	Bh	Reserved	Ch	12 clocks	Dh	Reserved	Eh	14 clocks	Fh	Reserved	10h	16 clocks	11h	Reserved	12h	18 clocks	1Fh-13h	Reserved
Bits	Description																												
4h-0h	Reserved																												
8h-5h	8 to 5 clocks																												
9h	Reserved																												
Ah	10 clocks																												
Bh	Reserved																												
Ch	12 clocks																												
Dh	Reserved																												
Eh	14 clocks																												
Fh	Reserved																												
10h	16 clocks																												
11h	Reserved																												
12h	18 clocks																												
1Fh-13h	Reserved																												

D18F2x[234:230]_dct[0] DDR3 DRAM Read ODT Pattern [High:Low]

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). This register is used by BIOS to specify the state of the ODT pins during DDR reads. F2x230 is used to control chip selects 0-3. F2x234 is used to control chip selects 4-7.

See [2.9.7.6.5 \[DRAM ODT Control\]](#) for more information.

Bits	Description
31:28	Reserved.
27:24	RdOdtPatCs73: read ODT pattern chip select [7,3]. See: RdOdtPatCs40.
23:20	Reserved.
19:16	RdOdtPatCs62: read ODT pattern chip select [6,2]. See: RdOdtPatCs40.
15:12	Reserved.
11:8	RdOdtPatCs51: read ODT pattern chip select [5,1]. See: RdOdtPatCs40.
7:4	Reserved.
3:0	RdOdtPatCs40: read ODT pattern chip select [4,0]. Read-write. Specifies the state of ODT[3:0] pins when a read occurs to the specified chip select.

D18F2x[23C:238]_dct[0] DDR3 DRAM Write ODT Pattern [High:Low]

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). This register is used by BIOS to specify the state of the ODT pins during DDR writes. F2x238 is used to control chip selects 0-3. F2x23C is used to control chip selects 4-7.

See [2.9.7.6.5 \[DRAM ODT Control\]](#) for more information.

Bits	Description
31:28	Reserved.
27:24	WrOdtPatCs73: write ODT pattern chip select [7,3]. See: WrOdtPatCs40.
23:20	Reserved.
19:16	WrOdtPatCs62: write ODT pattern chip select [6,2]. See: WrOdtPatCs40.
15:12	Reserved.
11:8	WrOdtPatCs51: write ODT pattern chip select [5,1]. See: WrOdtPatCs40.
7:4	Reserved.
3:0	WrOdtPatCs40: write ODT pattern chip select [4,0]. Read-write. Specifies the state of ODT[3:0] pins when a write occurs to the specified chip select.

D18F2x240_dct[0]_mp[1:0] DDR3 DRAM ODT Control

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description						
31:15	Reserved.						
14:12	WrOdtOnDuration: write ODT on duration. Read-write. BIOS: 6. Specifies the number of memory clock cycles that ODT is asserted for writes. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>5h-0h</td><td>Reserved</td></tr> <tr> <td>7h-6h</td><td><WrOdtOnDuration> clocks</td></tr> </table>	<u>Bits</u>	<u>Description</u>	5h-0h	Reserved	7h-6h	<WrOdtOnDuration> clocks
<u>Bits</u>	<u>Description</u>						
5h-0h	Reserved						
7h-6h	<WrOdtOnDuration> clocks						
11	Reserved.						

10:8	WrOdtTrnOnDly: Write ODT Turn On Delay. Read-write. BIOS: 0. Specifies the number of memory clock cycles that ODT assertion is delayed relative to write CAS. <div> <div><u>Bits</u></div> <div><u>Description</u></div> </div> 0h 0 clocks 7h-1h <WrOdtTrnOnDly> clocks, Reserved if (WrOdtOnDuration=0)
7:4	RdOdtOnDuration: Read ODT On Duration. Read-write. BIOS: 6. Specifies the number of memory clock cycles that ODT is asserted for an eight-beat read burst. The controller will shorten the ODT pulse duration by two clock cycles if the burst is chopped. <div> <div><u>Bits</u></div> <div><u>Description</u></div> </div> 5h-0h Reserved 9h-6h <RdOdtOnDuration> clocks Fh-Ah Reserved
3:0	RdOdtTrnOnDly: Read ODT Turn On Delay. Read-write. BIOS: MAX(0, D18F2x200_dct[0]_mp[1:0][Tcl] - D18F2x20C_dct[0]_mp[1:0][Tcwl]). Specifies the number of clock cycles that ODT assertion is delayed relative to read CAS. <div> <div><u>Bits</u></div> <div><u>Description</u></div> </div> 0h 0 clocks Fh-0h <RdOdtTrnOnDly> clocks, Reserved if (RdOdtOnDuration=0)

D18F2x244_dct[0] DRAM Controller Miscellaneous 3

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers].

Bits	Description
31:28	Reserved.
27	LoadOddTmgOptDis: load odd timing optimization disable. Read-write.
26	DisDlyInvertCmd: disable delay invert comand. Read-write.
25:15	Reserved.
14:13	Reserved.
12:8	Reserved.
7:4	Reserved.
3:0	PrtlChPDDynDly: partial channel power down dynamic delay. Read-write. BIOS: 4h. Specifies the channel idle hysteresis for fast exit/slow exit mode changes when D18F2xA8_dct[0][PrtlChP-DEnhEn]=1. <div> <div><u>Bits</u></div> <div><u>Description</u></div> </div> 0h 0 clocks 7h-1h <PrtlChPDDynDly*32> clocks 8h 256 clocks Fh-9h Reserved

D18F2x248_dct[0]_mp[1:0] DRAM Power Management 0

Reset: 0000_0A03h. See 2.9.3 [DCT Configuration Registers].

Bits	Description										
31	RxChMntClkEn: Receive channel maintenance clocks. Read-write. BIOS: 0. 1=Enable receive channel maintenance clocks to improve internal timing margin at the cost of some extra power. 0=Disable clocks. To disable clocks, BIOS must first disable clock generation in the phy (see D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0][RxSsbMntClkEn]).										
30	Reserved.										
29:24	AggrPDDelay: aggressive power down delay. Read-write. BIOS: 20h. Specifies a hysteresis count from the last DRAM activity for the DCT to close pages prior to precharge power down. Reserved if D18F2xA8_dct[0][AggrPDEn]==0 . See PchgPDEnDelay and D18F2x94_dct[0][PowerDownEn] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>64 clocks</td></tr> <tr> <td>01h</td><td>1 clock</td></tr> <tr> <td>3Eh-02h</td><td><AggrPDDelay> clocks</td></tr> <tr> <td>3Fh</td><td>63 clocks</td></tr> </table>	Bits	Description	00h	64 clocks	01h	1 clock	3Eh-02h	<AggrPDDelay> clocks	3Fh	63 clocks
Bits	Description										
00h	64 clocks										
01h	1 clock										
3Eh-02h	<AggrPDDelay> clocks										
3Fh	63 clocks										
23:22	Reserved.										
21:16	PchgPDEnDelay: precharge power down entry delay. Read-write. BIOS: IF (D18F2xA8_dct[0][AggrPDEn]) THEN (D18F2x200_dct[0]_mp[1:0][Tcl] + 5 + CEIL((MAX(D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay]) + 0.5) / 2)) ELSE 00h ENDIF. Specifies the power down entry delay. If D18F2xA8_dct[0][AggrPDEn]==0 , this delay behaves as a hysteresis. This field must satisfy the minimum power down entry delay requirements. See also D18F2x94_dct[0][PowerDownEn] . $\text{PchgPDEnDelay} == 0 \parallel \text{PchgPDEnDelay} \geq \text{D18F2x200_dct[0]_mp[1:0][Tcl]} + 5 + \text{CEIL}((\text{MAX}(\text{D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0][DqsRcvEnGrossDelay]) + 0.5) / 2).$ <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>64 clocks</td></tr> <tr> <td>01h</td><td>1 clock</td></tr> <tr> <td>3Eh-02h</td><td><PchgPDEnDelay> clocks</td></tr> <tr> <td>3Fh</td><td>63 clocks</td></tr> </table>	Bits	Description	00h	64 clocks	01h	1 clock	3Eh-02h	<PchgPDEnDelay> clocks	3Fh	63 clocks
Bits	Description										
00h	64 clocks										
01h	1 clock										
3Eh-02h	<PchgPDEnDelay> clocks										
3Fh	63 clocks										
15:13	Reserved.										
12:8	Txpdll: exit DLL and precharge powerdown to command delay. Read-write. Specifies the minimum time that the DCT waits to issue a command after exiting precharge powerdown mode if the DLL was also disabled. Reserved if !Ddr3Mode. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>09h-00h</td><td>Reserved</td></tr> <tr> <td>1Dh-0Ah</td><td><Txpdll> clocks</td></tr> <tr> <td>1Fh-1Eh</td><td>Reserved</td></tr> </table>	Bits	Description	09h-00h	Reserved	1Dh-0Ah	<Txpdll> clocks	1Fh-1Eh	Reserved		
Bits	Description										
09h-00h	Reserved										
1Dh-0Ah	<Txpdll> clocks										
1Fh-1Eh	Reserved										

7:4	Reserved.								
3:0	Txp: exit precharge PD to command delay. Read-write. Specifies the minimum time that the DCT waits to issue a command after exiting precharge powerdown mode. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>2h-0h</td><td>Reserved</td></tr> <tr> <td>8h-3h</td><td><Txp> clocks</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>	Bits	Description	2h-0h	Reserved	8h-3h	<Txp> clocks	Fh-9h	Reserved
Bits	Description								
2h-0h	Reserved								
8h-3h	<Txp> clocks								
Fh-9h	Reserved								

D18F2x24C_dct[0] DDR3 DRAM Power Management 1

Reset: 0214_0803h. See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description								
31:30	Reserved.								
29:24	Tcksrx: clock stable to self refresh exit delay. Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to assert CKE after clock frequency is stable. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>0Eh-02h</td><td><Tcksrx> clocks</td></tr> <tr> <td>3Fh-0Fh</td><td>Reserved</td></tr> </table>	Bits	Description	01h-00h	Reserved	0Eh-02h	<Tcksrx> clocks	3Fh-0Fh	Reserved
Bits	Description								
01h-00h	Reserved								
0Eh-02h	<Tcksrx> clocks								
3Fh-0Fh	Reserved								
23:22	Reserved.								
21:16	Tcksre: self refresh to command delay. Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to remove external clocks after entering self refresh or powerdown. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>27h-05h</td><td><Tcksre> clocks</td></tr> <tr> <td>3Fh-28h</td><td>Reserved</td></tr> </table>	Bits	Description	04h-00h	Reserved	27h-05h	<Tcksre> clocks	3Fh-28h	Reserved
Bits	Description								
04h-00h	Reserved								
27h-05h	<Tcksre> clocks								
3Fh-28h	Reserved								
15:14	Reserved.								
13:8	Tckesr: self refresh to command delay. Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to issue a command after entering self refresh. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>2Bh-02h</td><td><Tckesr> clocks</td></tr> <tr> <td>3Fh-2Ch</td><td>Reserved</td></tr> </table>	Bits	Description	01h-00h	Reserved	2Bh-02h	<Tckesr> clocks	3Fh-2Ch	Reserved
Bits	Description								
01h-00h	Reserved								
2Bh-02h	<Tckesr> clocks								
3Fh-2Ch	Reserved								
7:4	Reserved.								
3:0	Tpd: minimum power down entry to exit. Read-write. Specifies minimum time in memory clock cycles for powerdown entry to exit timing. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Ah-1h</td><td><Tpd> clocks</td></tr> <tr> <td>Fh-Bh</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Reserved	Ah-1h	<Tpd> clocks	Fh-Bh	Reserved
Bits	Description								
0h	Reserved								
Ah-1h	<Tpd> clocks								
Fh-Bh	Reserved								

D18F2x250_dct[0] DRAM Loopback and Training Control

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Bits	Description														
31:21	Reserved.														
20:18	DataPatGenSel: data pattern generator select. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>PRBS23 I.</td></tr> <tr> <td>001b</td><td>PRBS23 II. Within a byte lane, the DQ[n] value is offset 8n bit times from DQ[0].</td></tr> <tr> <td>010b</td><td>Configurable data pattern. See D18F2x2[B4,B0,AC,A8]_dct[0].</td></tr> <tr> <td>011b</td><td>Configurable data pattern with circular lane shift. See D18F2x2[B4,B0,AC,A8]_dct[0].</td></tr> <tr> <td>100b</td><td>PRBS23 III. Within a byte lane, each DQ[n] value is equal to DQ[0].</td></tr> <tr> <td>111b-101b</td><td>Reserved.</td></tr> </table>	Bits	Description	000b	PRBS23 I.	001b	PRBS23 II. Within a byte lane, the DQ[n] value is offset 8n bit times from DQ[0].	010b	Configurable data pattern. See D18F2x2[B4,B0,AC,A8]_dct[0].	011b	Configurable data pattern with circular lane shift. See D18F2x2[B4,B0,AC,A8]_dct[0].	100b	PRBS23 III. Within a byte lane, each DQ[n] value is equal to DQ[0].	111b-101b	Reserved.
Bits	Description														
000b	PRBS23 I.														
001b	PRBS23 II. Within a byte lane, the DQ[n] value is offset 8n bit times from DQ[0].														
010b	Configurable data pattern. See D18F2x2[B4,B0,AC,A8]_dct[0].														
011b	Configurable data pattern with circular lane shift. See D18F2x2[B4,B0,AC,A8]_dct[0].														
100b	PRBS23 III. Within a byte lane, each DQ[n] value is equal to DQ[0].														
111b-101b	Reserved.														
17	ActPchgGenEn: activate precharge generation enable. IF ((D18F2x118[LockDramCfg])) THEN Read-only. ELSE Read-write. ENDIF. 1=The DCT generates ACT and PRE traffic in the available command bandwidth from SendCmd. 0=Traffic generation is not enabled. In usage, user should clear ActPchgGenEn prior to SendCmd. Reserved if ~CmdTestEnable.														
16	Reserved.														
15	Reserved.														
14	Reserved.														
13	LfsrRollOver: LFSR roll over. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the behavior of DataPrbsSeed and the data comparison logic if the generated address wraps around to equal D18F2x25[8,4]_dct[0][TgtAddress]. 0=The PRBS will not be re-seeded. 1=The PRBS will be re-seeded.														
12	CmdSendInProg: command in progress. Read-only; updated-by-hardware. 0=DCT is idle. 1=DCT is busy.														
11	SendCmd: send command. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 0=Stop command generation. 1=Begin command generation as specified in CmdTgt, Cmd-Type, and D18F2x260_dct[0][CmdCount]. BIOS must set this field to a 0 after a command series is completed. Reserved if ~CmdTestEnable.														
10	TestStatus: test status. Read-only. 0=Command generation is in progress. 1=Command generation has completed. Reserved if ~(SendCmd & (D18F2x260_dct[0][CmdCount] > 0 StopOnErr)).														
9:8	CmdTgt: command target. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the SendCmd command target address mode. See D18F2x25[8,4]_dct[0]. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Issue commands to address Target A</td></tr> <tr> <td>01b</td><td>Issue alternating commands to address Target A and Target B</td></tr> <tr> <td>11b-10b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	Issue commands to address Target A	01b	Issue alternating commands to address Target A and Target B	11b-10b	Reserved						
Bits	Description														
00b	Issue commands to address Target A														
01b	Issue alternating commands to address Target A and Target B														
11b-10b	Reserved														

7:5	CmdType: command type. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the SendCmd command type. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Read</td></tr> <tr> <td>001b</td><td>Write</td></tr> <tr> <td>010b</td><td>Alternating write and read</td></tr> <tr> <td>111b-011b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	Read	001b	Write	010b	Alternating write and read	111b-011b	Reserved
Bits	Description										
000b	Read										
001b	Write										
010b	Alternating write and read										
111b-011b	Reserved										
4	StopOnError: stop on error. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the DCT behavior if a data comparison error occurs. 1=Stop command generation. 0=Continue command generation. If StopOnError=1, BIOS must program ResetAllErr=1 when programming SendCmd=1.										
3	ResetAllErr: reset all errors. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read; write-1-only; cleared-by-hardware. ENDIF. 1=Clear error status bits and error counters in D18F2x264_dct[0], D18F2x268_dct[0], and D18F2x26C_dct[0].										
2	CmdTestEnable: command test enable. IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 0=Disable the command generation mode. 1=Enable the command generation mode. See SendCmd.										
1:0	Reserved.										

D18F2x25[8,4]_dct[0] DRAM Target [B, A] Base

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Table 180: Register Mapping for D18F2x25[8,4]_dct[0]

Register	Function
D18F2x254_dct[0]	Target A
D18F2x258_dct[0]	Target B

Bits	Description				
31:27	Reserved.				
26:24	TgtChipSelect: target chip select. Read-write. Specifies the chip select. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>111b-000b</td><td>CS<TgtChipSelect></td></tr> </table>	Bits	Description	111b-000b	CS<TgtChipSelect>
Bits	Description				
111b-000b	CS<TgtChipSelect>				
23:21	TgtBank: target bank [2:0]. Read-write. Specifies the bank address.				
20:16	Reserved.				
15:10	TgtAddress[15:10]: target address [15:10]. Read-write. Specifies the upper column address bits [15:10]. Software must always program bit 10 and bit 12 equal to 0.				
9:0	TgtAddress[9:0]: target address [9:0]. Read-write. Specifies the column address bits [9:0]. The address sequencing in a command series occurs as follows: TgtAddress[9:3] is incremented by one with wrap around. The increment occurs after each command if D18F2x250_dct[0][CmdType] = 00xb or if (D18F2x250_dct[0][CmdType] = 010b and D18F2x250_dct[0][CmdTgt] = 01b). The increment occurs after each command pair if (D18F2x250_dct[0][CmdType] = 010b and D18F2x250_dct[0][CmdTgt] = 00b).				

D18F2x25C_dct[0] DRAM Command 0

Reset: 0000_0001h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Bits	Description										
31:22	BubbleCnt2: bubble count 2. See: BubbleCnt. Specifies the number of NOP commands inserted after the last clock of virtual CAS of each read-burst operation in alternating write and read mode. Defined only if (D18F2x250_dct[0][CmdType] == 010b); otherwise reserved.										
21:12	BubbleCnt: bubble count. Read-write. Specifies the number of NOP commands inserted after the last clock of virtual CAS of the last command of the command stream specified by CmdStreamLen. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000h</td><td>0 command bubbles</td></tr> <tr> <td>3FEh-001h</td><td><BubbleCnt> command bubbles</td></tr> <tr> <td>3FFh</td><td>3FFh command bubbles</td></tr> </table>	Bits	Description	000h	0 command bubbles	3FEh-001h	<BubbleCnt> command bubbles	3FFh	3FFh command bubbles		
Bits	Description										
000h	0 command bubbles										
3FEh-001h	<BubbleCnt> command bubbles										
3FFh	3FFh command bubbles										
11:9	Reserved.										
8	CmdTimingEn: command timing enable. Read-write. 1=Forces DCT to schedule commands initiated by D18F2x250_dct[0][SendCmd] to adhere to the same DRAM timing parameters as normal traffic. 0=Commands initiated by D18F2x250_dct[0][SendCmd] ignore DRAM timing parameters.										
7:0	CmdStreamLen: command stream length. Read-write. Specifies the number of commands generated before BubbleCnt bubbles are inserted. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>01h</td><td>1 command</td></tr> <tr> <td>FEh-02h</td><td><CmdStreamLen> commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)</td></tr> <tr> <td>FFh</td><td>255 commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)</td></tr> </table>	Bits	Description	00h	Reserved	01h	1 command	FEh-02h	<CmdStreamLen> commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)	FFh	255 commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)
Bits	Description										
00h	Reserved										
01h	1 command										
FEh-02h	<CmdStreamLen> commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)										
FFh	255 commands; defined only if ~(D18F2x250_dct[0][CmdType]=010b)										

D18F2x260_dct[0] DRAM Command 1

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Bits	Description						
31:21	Reserved.						
20:0	CmdCount: command count. Read-write. Specifies the maximum number of commands to generate when D18F2x250_dct[0][SendCmd]=1. See also D18F2x250_dct[0][StopOnErr]. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Infinite commands.</td></tr> <tr> <td>1F_FFFFh-1h</td><td><CmdCount> commands</td></tr> </table>	Bits	Description	0h	Infinite commands.	1F_FFFFh-1h	<CmdCount> commands
Bits	Description						
0h	Infinite commands.						
1F_FFFFh-1h	<CmdCount> commands						

D18F2x264_dct[0] DRAM Status 0

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Bits	Description
31:25	ErrDqNum: error DQ number. Read-only. Indicates the DQ bit of the first error occurrence when D18F2x264_dct[0][ErrCnt] > 0. Cleared by D18F2x250_dct[0][ResetAllErr] .
<u>Bits</u>	<u>Description</u>
3Fh-00h	Data[<ErrDqNum>]
47h-40h	ECC[7:0]
7Fh-48h	Reserved
24:0	ErrCnt: error count. Read; set-by-hardware; write-1-to-clear. Specifies a saturating counter indicating the number of DQ bit errors detected. Counts a maximum of 1 error per bit-lane per each bit-time. Status is accumulated until cleared by D18F2x250_dct[0][ResetAllErr] . Errors can be masked on per-bit basis by programming D18F2x274_dct[0] , D18F2x278_dct[0] , and D18F2x27C_dct[0] .
<u>Bits</u>	<u>Description</u>
0h	0 errors
1FF_FFFDh-1h	<ErrCnt> errors
1FF_FFFEh	1FF_FFFEh errors
1FF_FFFFh	1FF_FFFFh or more errors

D18F2x268_dct[0] DRAM Status 1

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
31:20	Reserved.
19:0	NibbleErrSts: nibble error status. Read-only. Indicates error detection status on a per nibble basis when D18F2x264_dct[0][ErrCnt] > 0. Status is accumulated until cleared by D18F2x250_dct[0][ResetAllErr] .
<u>Bit</u>	<u>Description</u>
[15:0]	Data[<(NibbleErrSts*4)+3>:<NibbleErrSts*4>]
[16]	ECC[3:0]
[17]	ECC[7:4]
[19:18]	Reserved

D18F2x26C_dct[0] DRAM Status 2

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
------	-------------

31:18	Reserved.								
17:0	<p>NibbleErr180Sts: nibble error 180 status. Read-only. Indicates error detection status on a per nibble basis when D18F2x264_dct[0][ErrCnt] > 0, comparing read data against data shifted 1-bit time earlier. Status is accumulated until cleared by D18F2x250_dct[0][ResetAllErr].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[15:0]</td><td>Data[<(NibbleErr180Sts)*4>+3>:<NibbleErr180Sts*4>]</td></tr> <tr> <td>[16]</td><td>ECC[3:0]</td></tr> <tr> <td>[17]</td><td>ECC[7:4]</td></tr> </table>	Bit	Description	[15:0]	Data[<(NibbleErr180Sts)*4>+3>:<NibbleErr180Sts*4>]	[16]	ECC[3:0]	[17]	ECC[7:4]
Bit	Description								
[15:0]	Data[<(NibbleErr180Sts)*4>+3>:<NibbleErr180Sts*4>]								
[16]	ECC[3:0]								
[17]	ECC[7:4]								

D18F2x270_dct[0] DRAM PRBS

See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
31	Reserved.
30:24	Reserved.
23:19	Reserved.
18:0	DataPrbsSeed: data PRBS seed. Read-write. Reset: 7FFFFh. Specifies the seed value used for creating pseudo random traffic on the data bus. This register must be written with a non-zero seed value.

D18F2x274_dct[0] DRAM DQ Mask Low

See [D18F1x10C\[DctCfgSel\]](#). See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description								
31:0	<p>DQMask[31:0]: DQ mask. Read-write. DQMask[63:0] = {D18F2x278_dct[0][DQMask[63:32]], DQMask[31:0]}. Reset: 0000_0000_0000_0000h. 1=The corresponding DQ bit will not be compared. 0=The corresponding DQ bit will be compared. See D18F2x264_dct[0][ErrCnt].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[0]</td></tr> <tr> <td>[62:1]</td><td>Data[<DQMask>]</td></tr> <tr> <td>[63]</td><td>Data[63]</td></tr> </table>	Bit	Description	[0]	Data[0]	[62:1]	Data[<DQMask>]	[63]	Data[63]
Bit	Description								
[0]	Data[0]								
[62:1]	Data[<DQMask>]								
[63]	Data[63]								

D18F2x278_dct[0] DRAM DQ Mask High

Bits	Description
31:0	DQMask[63:32]: DQ mask. See: D18F2x274_dct[0][DQMask[31:0]] .

D18F2x27C_dct[0] DRAM ECC and EDC Mask

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
31:20	Reserved.

19:16	Reserved.								
15:8	Reserved.								
7:0	<p>EccMask: ECC mask. Read-write. 1=The corresponding ECC DQ bit will not be compared. 0=The corresponding ECC DQ bit will be compared. See D18F2x264_dct[0][ErrCnt].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>ECC[0]</td></tr> <tr> <td>[6:1]</td><td>ECC[<EccMask>]</td></tr> <tr> <td>[7]</td><td>ECC[7].</td></tr> </table>	Bit	Description	[0]	ECC[0]	[6:1]	ECC[<EccMask>]	[7]	ECC[7].
Bit	Description								
[0]	ECC[0]								
[6:1]	ECC[<EccMask>]								
[7]	ECC[7].								

D18F2x280_dct[0] DRAM DQ Pattern Override 0

See [D18F1x10C\[DctCfgSel\]](#). See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description								
31:0	<p>DQPatOvrEn[31:0]: DQ pattern override enable. Read-write. DQPatOvrEn[63:0] = {D18F2x284_dct[0][DQPatOvrEn[63:32]], DQPatOvrEn[31:0]}. Reset: 0000_0000_0000_0000h. 1=The pattern on this DQ bit lane will be overridden with a static value specified by D18F2x288_dct[0][PatOvrVal]. 0=The pattern on this DQ bit lane will not be overridden. Reserved if D18F2x250_dct[0][DataPatGenSel] != 10b.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[0]</td></tr> <tr> <td>[62:1]</td><td>Data[<DQPatOvrEn[31:0]>]</td></tr> <tr> <td>[63]</td><td>Data[63]</td></tr> </table>	Bit	Description	[0]	Data[0]	[62:1]	Data[<DQPatOvrEn[31:0]>]	[63]	Data[63]
Bit	Description								
[0]	Data[0]								
[62:1]	Data[<DQPatOvrEn[31:0]>]								
[63]	Data[63]								

D18F2x284_dct[0] DRAM DQ Pattern Override 1

Bits	Description
31:0	DQPatOvrEn[63:32]: DQ pattern override enable. See: D18F2x280_dct[0][DQPatOvrEn[31:0]] .

D18F2x288_dct[0] DRAM DQ Pattern Override 2

Reset: 0000_0000h. See [D18F1x10C\[DctCfgSel\]](#). See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description										
31:24	<p>XorPatOvr: xor pattern override. Read-write. Specifies the override data pattern used for creating traffic on the data bus. The output data for each DQ of each byte lane will be XOR'd with the specified values. Reserved if D18F2x250_dct[0][DataPatGenSel] != 100b.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>DQ[0]</td></tr> <tr> <td>[1]</td><td>DQ[1]</td></tr> <tr> <td>[6:2]</td><td>DQ[<XorPatOvr>]</td></tr> <tr> <td>[7]</td><td>DQ[7]</td></tr> </table>	Bit	Description	[0]	DQ[0]	[1]	DQ[1]	[6:2]	DQ[<XorPatOvr>]	[7]	DQ[7]
Bit	Description										
[0]	DQ[0]										
[1]	DQ[1]										
[6:2]	DQ[<XorPatOvr>]										
[7]	DQ[7]										

23:9	Reserved.										
8	PatOvrVal: pattern override value. Read-write. Specifies the override data pattern used. for creating traffic on the data bus. 1=Static 1's. 0=Static 0's. Reserved if D18F2x250_dct[0][DataPatGenSel] != 10b .										
7:0	EccPatOvrEn: ECC pattern override enable. Read-write. See D18F2x280_dct[0][DQPatOvrEn] <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>ECC[0]</td></tr> <tr> <td>[1]</td><td>ECC[1]</td></tr> <tr> <td>[6:2]</td><td>ECC[<EccPatOvr>]</td></tr> <tr> <td>[7]</td><td>ECC[7].</td></tr> </table>	Bit	Description	[0]	ECC[0]	[1]	ECC[1]	[6:2]	ECC[<EccPatOvr>]	[7]	ECC[7].
Bit	Description										
[0]	ECC[0]										
[1]	ECC[1]										
[6:2]	ECC[<EccPatOvr>]										
[7]	ECC[7].										

D18F2x28C_dct[0] DRAM Command 2

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#). This register may only be used when [D18F2x250_dct\[0\]\[CmdTestEnable\]=1](#).

Bits	Description				
31	SendActCmd: send activate command. Read; write-1-only; cleared-by-hardware. 1=The DCT sends an activate command as specified by ChipSelect, Bank, and Address. This bit is cleared by hardware after the command completes.				
30	SendPchgCmd: send precharge all command. Read; write-1-only; cleared-by-hardware. The DCT sends a precharge command based on CmdAddress[10]. This bit is cleared by hardware after the command completes. 0=Command has completed. 1=If (CmdAddress[10]=1) then send a precharge all command as specified by CmdChipSelect; If (CmdAddress[10]=0) then send a precharge command as specified by CmdChipSelect, CmdBank.				
29:22	CmdChipSelect: command chip select. Read-write. Specifies the chip select. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[7:0]</td><td>CS<CmdChipSelect></td></tr> </table>	Bit	Description	[7:0]	CS<CmdChipSelect>
Bit	Description				
[7:0]	CS<CmdChipSelect>				
21:19	CmdBank: command bank [2:0]. Read-write. Specifies the bank address. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Bank<CmdBank></td></tr> </table>	Bits	Description	7h-0h	Bank<CmdBank>
Bits	Description				
7h-0h	Bank<CmdBank>				
18	Reserved.				
17:0	CmdAddress: command address [17:0]. Read-write. Specifies the row address.				

D18F2x290_dct[0] DRAM Status 3

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
31:27	Reserved.

26:24	ErrBeatNum: error beat number. Read-only. Indicates the data beat of the first error occurrence in the command reported by ErrCmdNum when D18F2x264_dct[0][ErrCnt] > 0 and D18F2x260_dct[0][CmdCount] > 0. Cleared by D18F2x250_dct[0][ResetAllErr] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td><ErrBeatNum> beat</td></tr> </table>	Bits	Description	7h-0h	<ErrBeatNum> beat
Bits	Description				
7h-0h	<ErrBeatNum> beat				
23:21	Reserved.				
20:0	ErrCmdNum: error command number. Read-only. Indicates the command number of the first error occurrence when D18F2x264_dct[0][ErrCnt] > 0 and D18F2x260_dct[0][CmdCount] > 0. Cleared by D18F2x250_dct[0][ResetAllErr] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1F_FFFFh-0h</td><td><ErrCmdNum> command</td></tr> </table>	Bits	Description	1F_FFFFh-0h	<ErrCmdNum> command
Bits	Description				
1F_FFFFh-0h	<ErrCmdNum> command				

D18F2x294_dct[0] DRAM Status 4

See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description								
31:0	DQErr[31:0]: DQ error. Read-only. DQErr[63:0] = { D18F2x298_dct[0][DQErr[63:32]] , DQErr[31:0]}. Reset: 0000_0000_0000_0000h. Indicates error detection status on a per bit basis when D18F2x264_dct[0][ErrCnt] > 0. Status is accumulated until cleared by D18F2x250_dct[0][ResetAllErr] . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[0]</td></tr> <tr> <td>[62:1]</td><td>Data[<DQErr>]</td></tr> <tr> <td>[63]</td><td>Data[63]</td></tr> </table>	Bit	Description	[0]	Data[0]	[62:1]	Data[<DQErr>]	[63]	Data[63]
Bit	Description								
[0]	Data[0]								
[62:1]	Data[<DQErr>]								
[63]	Data[63]								

D18F2x298_dct[0] DRAM Status 5

Bits	Description
31:0	DQErr[63:32]: DQ error. See: D18F2x294_dct[0][DQErr[31:0]] .

D18F2x29C_dct[0] DRAM Status 6

Reset: 0000_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.8 \[Continuous Pattern Generation\]](#).

Bits	Description
31:20	Reserved.
19:16	Reserved.

15:8	Reserved.								
7:0	EccErr: ECC error. Read-only. Indicates ECC error detection status on a per bit basis when D18F2x264_dct[0][ErrCnt] > 0. Status is accumulated until cleared by D18F2x250_dct[0][ResetAll-Err] . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>ECC[0]</td></tr> <tr> <td>[6:1]</td><td>ECC[<EccErr>]</td></tr> <tr> <td>[7]</td><td>ECC[7]</td></tr> </table>	Bit	Description	[0]	ECC[0]	[6:1]	ECC[<EccErr>]	[7]	ECC[7]
Bit	Description								
[0]	ECC[0]								
[6:1]	ECC[<EccErr>]								
[7]	ECC[7]								

D18F2x2[B4,B0,AC,A8]_dct[0] DRAM User Data Pattern

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Table 181: Register Mapping for D18F2x2[B4,B0,AC,A8]_dct[0]

Register	Function
D18F2x2A8_dct[0]	Nibble Lanes 0, 4, 8, 12, 16
D18F2x2AC_dct[0]	Nibble Lanes 1, 5, 9, 13, 17
D18F2x2B0_dct[0]	Nibble Lanes 2, 6, 10, 14
D18F2x2B4_dct[0]	Nibble Lanes 3, 7, 11, 15

Table 182: Field Mapping for D18F2x2[B4,B0,AC,A8]_dct[0]

Register	Bits			
	31:24	23:16	15:8	7:0
D18F2x2A8_dct[0]	DQ3_DQ19_ DQ35_DQ51_ ECC3	DQ2_DQ18_ DQ34_DQ50_ ECC2	DQ1_DQ17_ DQ33_DQ49_ ECC1	DQ0_DQ16_ DQ32_DQ48_ ECC0
D18F2x2AC_dct[0]	DQ7_DQ23_ DQ39_DQ55_ ECC7	DQ6_DQ22_ DQ38_DQ54_ ECC6	DQ5_DQ21_ DQ37_DQ53_ ECC5	DQ4_DQ20_ DQ36_DQ52_ ECC4
D18F2x2B0_dct[0]	DQ11_DQ27_ DQ43_DQ59	DQ10_DQ26_ DQ42_DQ58	DQ9_DQ25_ DQ41_DQ57	DQ8_DQ24_ DQ40_DQ56
D18F2x2B4_dct[0]	DQ15_DQ31_ DQ47_DQ63	DQ14_DQ30_ DQ46_DQ62	DQ13_DQ29_ DQ45_DQ61	DQ12_DQ28_ DQ44_DQ60

Bits	Description								
31:24	DataPattern: data pattern. See: D18F2x2[B4,B0,AC,A8]_dct[0][7:0] .								
23:16	DataPattern: data pattern. See: D18F2x2[B4,B0,AC,A8]_dct[0][7:0] .								
15:8	DataPattern: data pattern. See: D18F2x2[B4,B0,AC,A8]_dct[0][7:0] .								
7:0	DataPattern: data pattern. Read-write. Specifies a data pattern used for creating traffic on the data bus for the specified bit lanes. See D18F2x250_dct[0][DataPatGenSel] . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Pattern Data Beat 0</td></tr> <tr> <td>[6:1]</td><td>Pattern Data Beat 1 to Pattern Data Beat 6</td></tr> <tr> <td>[7]</td><td>Pattern Data Beat 7</td></tr> </table>	Bit	Description	[0]	Pattern Data Beat 0	[6:1]	Pattern Data Beat 1 to Pattern Data Beat 6	[7]	Pattern Data Beat 7
Bit	Description								
[0]	Pattern Data Beat 0								
[6:1]	Pattern Data Beat 1 to Pattern Data Beat 6								
[7]	Pattern Data Beat 7								

D18F2x2B8_dct[0] DRAM Command 3

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Bits	Description								
31:16	ActPchgSeq: activate precharge sequence. Read-write. Specifies the command that will be generated in the sequence, corresponding to the sixteen target entries in D18F2x2[C0,BC]_dct[0] . 1=Activate. 0=Precharge. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>ACT/PRE [0]</td></tr> <tr> <td>[14:1]</td><td>ACT/PRE [<ActPchgSeq>]</td></tr> <tr> <td>[15]</td><td>ACT/PRE [15]</td></tr> </table>	Bit	Description	[0]	ACT/PRE [0]	[14:1]	ACT/PRE [<ActPchgSeq>]	[15]	ACT/PRE [15]
Bit	Description								
[0]	ACT/PRE [0]								
[14:1]	ACT/PRE [<ActPchgSeq>]								
[15]	ACT/PRE [15]								
15:12	Reserved.								
11:8	ActPchgCmdMin: activate precharge command minimum. Read-write. Specifies the minimum time in memory clock cycles from an activate or precharge command to the next activate or precharge command in the ActPchgSeq sequence. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0</td><td>Reserved</td></tr> <tr> <td>Fh-1h</td><td>[<ActPchgCmdMin>] clocks</td></tr> </table>	Bits	Description	0	Reserved	Fh-1h	[<ActPchgCmdMin>] clocks		
Bits	Description								
0	Reserved								
Fh-1h	[<ActPchgCmdMin>] clocks								
7:0	Reserved.								

D18F2x2[C0,BC]_dct[0] DRAM Command 4 & 5

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.8 [Continuous Pattern Generation].

Table 183: Field Mappings for [D18F2x2\[C0,BC\]_dct\[0\]](#)

Register	Bits							
	31:28	27:24	23:20	19:16	15:12	11:8	7:4	3:0
D18F2x2BC_dct[0]	ACT_PRE 7	ACT_PRE 6	ACT_PRE 5	ACT_PRE 4	ACT_PRE 3	ACT_PRE 2	ACT_PRE 1	ACT_PRE 0
D18F2x2C0_dct[0]	ACT_PRE 15	ACT_PRE 14	ACT_PRE 13	ACT_PRE 12	ACT_PRE 11	ACT_PRE 10	ACT_PRE 9	ACT_PRE 8

Bits	Description
31:28	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].
27:24	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].
23:20	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].
19:16	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].
15:12	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].
11:8	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0] [3:0].

7:4	ActPchgTgtBank: activate precharge target bank. See: D18F2x2[C0,BC]_dct[0][3:0] .						
3:0	<p>ActPchgTgtBank: activate precharge target bank. Read-write. Specifies the bank address used for this command of the sequence.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Bank [<ActPchgTgtBank>]</td></tr> <tr> <td>Fh-8h</td><td>Reserved</td></tr> </table>	Bits	Description	7h-0h	Bank [<ActPchgTgtBank>]	Fh-8h	Reserved
Bits	Description						
7h-0h	Bank [<ActPchgTgtBank>]						
Fh-8h	Reserved						

D18F2x2E0_dct[0] Memory P-state Control and Status

See 2.9.3 [DCT Configuration Registers].

Bits	Description								
31	Reserved.								
30	FastMstateDis: fast M-state change disable. Read-write. Reset: 0. 1=The DCT changes MEMCLK frequency only after the NCLK frequency has changed. 0=The DCT changes MEMCLK frequency while the northbridge changes NCLK.								
29	Reserved.								
28:24	M1MemClkFreq: M1 memory clock frequency. Read-write. Reset: 00h. Specifies the frequency of the DRAM interface (MEMCLK) for memory P-state 1. See Table 136 [Valid Values for Memory Clock Frequency Value Definition] . The hardware enforces D18F5x84[DdrMaxRateEnf] when writes to this field occur. See D18F5x84[DdrMaxRate] and D18F5x84[DdrMaxRateEnf] . BIOS must also program D18F2x9C_x0D0F_E000_dct[0]_mp[1:0][Rate] for M1.								
23	Reserved.								
22:20	<p>MxMrsEn: Mx Mrs enable. Read-write. Reset:0h. 1=The DCT writes to the DRAM MR after a memory P-state change. 0=The DCT does not write to the DRAM MR.</p> <table> <tr> <th>Bit</th><th>Description, MR value</th></tr> <tr> <td>[0]</td><td>MR0, D18F2x2E8_dct[0]_mp[1:0][MxMr0]</td></tr> <tr> <td>[1]</td><td>MR1, D18F2x2E8_dct[0]_mp[1:0][MxMr1]</td></tr> <tr> <td>[2]</td><td>MR2, D18F2x2EC_dct[0]_mp[1:0][MxMr2]</td></tr> </table>	Bit	Description, MR value	[0]	MR0, D18F2x2E8_dct[0]_mp[1:0][MxMr0]	[1]	MR1, D18F2x2E8_dct[0]_mp[1:0][MxMr1]	[2]	MR2, D18F2x2EC_dct[0]_mp[1:0][MxMr2]
Bit	Description, MR value								
[0]	MR0, D18F2x2E8_dct[0]_mp[1:0][MxMr0]								
[1]	MR1, D18F2x2E8_dct[0]_mp[1:0][MxMr1]								
[2]	MR2, D18F2x2EC_dct[0]_mp[1:0][MxMr2]								
19:1	Reserved.								
0	CurMemPstate: current memory P-state. Reset: 0h. Read-only; updated-by-hardware. Specifies the current memory P-state. 0=M0. 1=M1.								

D18F2x2E8_dct[0]_mp[1:0] MRS Buffer

See 2.9.3 [DCT Configuration Registers].

Bits	Description
31:16	MxMr1: Mx MR1. Read-write. Reset: 0000h. Specifies the value written to DRAM MR1 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming D18F2x2E0_dct[0][MxMrsEn]=0 .
15:0	MxMr0: Mx MR0. Read-write. Reset: 0000h. Specifies the value written to DRAM MR0 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming D18F2x2E0_dct[0][MxMrsEn]=0 .

D18F2x2EC_dct[0]_mp[1:0] MRS Buffer

See 2.9.3 [DCT Configuration Registers].

Bits	Description
31:16	Reserved.
15:0	MxMr2: Mx MR2. Read-write. Reset: 0000h. Specifies the value written to DRAM MR2 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming D18F2x2E0_dct[0][MxMrsEn]=0 .

D18F2x2F0_dct[0]_mp[1:0] DRAM Controller Misc 3

See 2.9.3 [DCT Configuration Registers].

Bits	Description
31:1	Reserved.
0	EffArbDis: Efficient arbitration disable. Read-write. Reset: 0. BIOS: 0. 0=The DCT optimizes the arbitration phases to improve performance under certain traffic conditions whenever the NCLK to MEMCLK ratio is less than 2:1. 1=The DCT arbitrates normally, at all NCLK:MEMCLK ratios.

D18F2x400_dct[0] GMC to DCT Control 0

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers].

The GMC to DCT interface controls how DRAM bus resources are allocated and arbitrated between the MCT and the GMC. A token is the unit of available resource and is equivalent to a DCQ entry. A minimum count ensures a number of available DCQ entries. A token limit for MCT or GMC ensures resources are not all allocated to the GMC, or MCT respectively. Limits are configured bimodal: for normal GMC traffic and for when urgent (nominally display refresh) GMC traffic is occurring.

$$\text{D18F2x400_dct[0][MctTokenLimit]} + \text{D18F2x400_dct[0][GmcTokenLimit]} \leq 16.$$

$$\text{D18F2x400_dct[0][GmcTokenLimit]} \geq 1.$$

$$\text{D18F2x400_dct[0][MctTokenLimit]} \geq 1.$$

$$\text{D18F2x404_dct[0][UrGmcTokenLimit]} + \text{D18F2x404_dct[0][UrMctTokenLimit]} \leq 16.$$

$$\text{D18F2x404_dct[0][UrGmcMinTokens]} + \text{D18F2x404_dct[0][UrMctMinTokens]} \leq 16.$$

$$\text{D18F2x400_dct[0][MctTokenLimit]} == \text{D18F2x404_dct[0][UrMctTokenLimit]}.$$

Bits	Description
31:16	Reserved.
15:12	Reserved.
11:8	GmcTokenLimit: GMC token limit. Read-write. BIOS: 4h. Limit of outstanding GMC tokens. <div style="display: flex; justify-content: space-between;"> <div style="text-align: left;"><u>Bits</u> Fh-0h</div> <div style="text-align: left;"><u>Description</u> <GmcTokenLimit> tokens</div> </div>
7:4	Reserved.
3:0	MctTokenLimit: MCT token limit. Read-write. BIOS: 4h. Limit of outstanding MCT tokens. <div style="display: flex; justify-content: space-between;"> <div style="text-align: left;"><u>Bits</u> Fh-0h</div> <div style="text-align: left;"><u>Description</u> <MctTokenLimit> tokens</div> </div>

D18F2x404_dct[0] GMC to DCT Control 1

Reset: 0000_0000h. See 2.9.3 [DCT Configuration Registers].

Bits	Description						
31	UrgentTknDis: Urgent token disable. Read-write. BIOS: 0. 0=When urgent GMC traffic is requested, override the programmed values in D18F2x400_dct[0] and force the token scheme to heavily weight towards graphics by using the programmable token limits in D18F2x404_dct[0] . 1=Token scheme remains at the previously programmed non-urgent token limits in D18F2x400_dct[0] regardless of urgent GMC traffic.						
30:28	Reserved.						
27:24	UrGmcMinTokens: Display refresh GMC minimum tokens. Read-write. BIOS: 4. Urgent mode minimum number of tokens assigned to the GMC. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>Fh-0h</td><td><UrGmcMinTokens> tokens</td></tr> </table>	Bits	Description	Fh-0h	<UrGmcMinTokens> tokens		
Bits	Description						
Fh-0h	<UrGmcMinTokens> tokens						
23:21	Reserved.						
20:16	UrGmcTokenLimit: Display refresh GMC token limit. Read-write. BIOS: 04h. Urgent mode limit of outstanding GMC tokens. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>10h-0h</td><td><UrGmcTokenLimit> tokens</td></tr> <tr> <td>1Fh-11h</td><td>Reserved</td></tr> </table>	Bits	Description	10h-0h	<UrGmcTokenLimit> tokens	1Fh-11h	Reserved
Bits	Description						
10h-0h	<UrGmcTokenLimit> tokens						
1Fh-11h	Reserved						
15:12	Reserved.						
11:8	UrMctMinTokens: Display refresh MCT minimum tokens. Read-write. BIOS: 4. Urgent mode minimum number of tokens assigned to the MCT. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>Fh-0h</td><td><UrMctMinTokens> tokens</td></tr> </table>	Bits	Description	Fh-0h	<UrMctMinTokens> tokens		
Bits	Description						
Fh-0h	<UrMctMinTokens> tokens						
7:5	Reserved.						
4:0	UrMctTokenLimit: Display refresh MCT token limit. Read-write. BIOS: 04h. Urgent mode limit of outstanding MCT tokens. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>10h-0h</td><td><UrMctTokenLimit> tokens</td></tr> <tr> <td>1Fh-11h</td><td>Reserved</td></tr> </table>	Bits	Description	10h-0h	<UrMctTokenLimit> tokens	1Fh-11h	Reserved
Bits	Description						
10h-0h	<UrMctTokenLimit> tokens						
1Fh-11h	Reserved						

D18F2x408_dct[0] GMC to DCT Control 2

See 2.9.3 [DCT Configuration Registers].

Bits	Description						
31:29	Reserved.						
28:24	CpuElevPrioPeriod: Cpu elevate priority period. Read-write. Reset: 0. BIOS: Ch. Specifies the hysteresis of how often a new MCT read can be elevated to high priority if no other MCT reads currently exist in the DCQ. If CpuElevPrioPeriod==0, MCT will continuously elevate the priority of a new lone MCT read to high. Reserved if CpuElevPrioDis==1. Since this field controls internal timing in the NCLK domain, external bus equivalence is approximate. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>hysteresis counter disabled</td></tr> <tr> <td>1Fh-01h</td><td><CpuElevPrioPeriod*32> MEMCLKs</td></tr> </table>	Bits	Description	00h	hysteresis counter disabled	1Fh-01h	<CpuElevPrioPeriod*32> MEMCLKs
Bits	Description						
00h	hysteresis counter disabled						
1Fh-01h	<CpuElevPrioPeriod*32> MEMCLKs						

23:3	Reserved.
2	NonP0UrgentTknDis: non-P0 urgent token disable. Read-write. Reset: 0. BIOS: 0. 0=Switch from normal GMC traffic token scheme defined by D18F2x400_dct[0] to urgent GMC traffic token scheme defined by D18F2x404_dct[0] when all processors are not in software P0 state. 1=Use normal GMC traffic token scheme when all processors are not in software P0 state.
1	TokenAllocSelect: Token allocation select. Read-write. Reset: 0. BIOS: 0. 0=When both the MCT and GMC have less than their maximum outstanding tokens, tokens are allocated by alternating between each. 1= When both the MCT and GMC have less than their maximum outstanding tokens, tokens are allocated to whichever has less (DCQ entries + current outstanding).
0	CpuElevPrioDis: Cpu elevate priority disable. Read-write. Reset: 0. BIOS: 0. 1=Reads from MCT arbitrate with GMC traffic normally. 0=Elevate the priority of a new MCT read to high if no other MCT reads currently exist in the DCQ. This can alleviate CPU stalls during very long graphics requests.

D18F2x420_dct[0] GMC to DCT FIFO Config 1

See [2.9.3 \[DCT Configuration Registers\]](#).

Bits	Description
31:12	Reserved.
11:8	Reserved.
7:4	Reserved.
3:0	Reserved.

3.12 Device 18h Function 3 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F3x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1583h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F3x04 Status/Command

Bits	Description
31:16	Status. Read-only. Reset: 0000h, except bit[20]. Bit[20] is set to indicate the existence of a PCI-defined capability block, if one exists.
15:0	Command. Read-only. Reset: 0000h.

D18F3x08 Class Code/Revision ID

Bits	Description
31:8	ClassCode. Read-only. Reset: 060000h. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only. Reset: 00h.

D18F3x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:0	HeaderTypeReg. Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device.

D18F3x34 Capability Pointer

Bits	Description
31:8	Reserved.
7:0	CapPtr. Read-only. Value: F0h. Points to D18F3xF0 to provide capability.

D18F3x40 MCA NB Control

Read-write. Reset: 0000_0000h. [MSR0000_0410](#)[31:0] is an alias of [D18F3x40](#). See [MSR0000_0410](#)[31:0].

Bits	Description
31	McaCpuDatErrEn: L2 complex data error. 1=Enables MCA reporting of CPU data errors sent to the NB.
30	Unused.
29:28	Unused.
27	Unused.
26	NbArrayParEn: northbridge array parity error reporting enable. 1=Enables reporting of parity errors in the NB arrays.
25	UsPwDatErrEn: upstream data error enable. Read-write. 1=Enables MCA reporting of upstream posted writes in which the EP bit is set.
24:18	Unused.
17	CpPktDatEn: completion packet error reporting enable. Read-write. 1=Enables MCA reporting of completion packets with the EP bit set.
16	NbIntProtEn: northbridge internal bus protocol error reporting enable. Read-write. 1=Enables MCA reporting of protocol errors detected on the northbridge internal bus. When possible, this enable should be cleared before initiating a warm reset to avoid logging spurious errors due to RESET_L signal skew.
15:13	Unused.
12	WDTRptEn: watchdog timer error reporting enable. 1=Enables MCA reporting of watchdog timer errors. The watchdog timer checks for NB system accesses for which a response is expected but no response is received. See D18F3x44 [MCA NB Configuration] for information regarding configuration of the watchdog timer duration. This bit does not affect operation of the watchdog timer in terms of its ability to complete an access that would otherwise cause a system hang. This bit only affects whether such errors are reported through MCA.
11	AtomicRMWEn: atomic read-modify-write error reporting enable. 1=Enables MCA reporting of atomic read-modify-write (RMW) commands received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by this bit.
10	Unused.
9	TgtAbortEn: target abort error reporting enable. 1=Enables MCA reporting of target aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.
8	MstrAbortEn: master abort error reporting enable. 1=Enables MCA reporting of master aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.
7:6	Unused.
5	SyncPktEn: link sync packet error reporting enable. 1=Enables MCA reporting of link-defined sync error packets detected on link. The NB floods its outgoing link with sync packets after detecting a sync packet on the incoming link independent of the state of this bit.

4:2	Unused.
1	UECCEn: uncorrectable ECC error reporting enable. 1=Enables MCA reporting of DDR3 DRAM uncorrectable ECC errors which are detected in the NB. In some cases data may be forwarded to the core prior to checking ECC in which case the check takes place in one of the other error reporting banks.
0	CECCEn: correctable ECC error reporting enable. 1=Enables MCA reporting of DDR3 DRAM correctable ECC errors which are detected in the NB.

D18F3x44 MCA NB Configuration

See [D18F3x180 \[Extended NB MCA Configuration\]](#). It is expected that all fields of this register are programmed to the same value in all nodes, except for the fields used for link error injection: GenLinkSel, GenSubLinkSel, GenCrcErrByte1, GenCrcErrByte0.

Bits	Description
31	NbMcaLogEn: northbridge MCA log enable. Read-write. Reset: 0. 1=Enables logging (but not reporting) of NB MCA errors even if MCA is not globally enabled.
30	SyncFloodOnDramAdrParErr: sync flood on DRAM address parity error. Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood on detection of a DRAM address parity error.
29	DisMstAbortCpuErrRsp: master abort CPU error response disable. Read-write. Reset: 0. 1=Disables master abort reporting through the CPU MCA error-reporting banks; Suppresses sending of RDE to CPU; Does not log any MCA information in the NB.
28	DisTgtAbortCpuErrRsp: target abort CPU error response disable. Read-write. Reset: 0. 1=Disables target abort reporting through the CPU MCA error-reporting banks; Suppresses sending of RDE to CPU; Does not log any MCA information in the NB.
27	<p>NbMcaToMstCpuEn: machine check errors to master CPU only. Read-write. Reset: 0. BIOS: 1. 1=NB MCA errors in CMP device are only reported to the node base core (NBC), and the NB MCA registers in MSR space (MSR0000_0410, MSR0000_0411, MSR0000_0412, MSR0000_0413, MSR0000_0408, and MSRC001_0048) are only accessible from the NBC; reads of these MSRs from other cores return 0's and writes are ignored. This allows machine check handlers running on different cores to avoid coordinating accesses to the NB MCA registers. This field does not affect PCI-defined configuration space accesses to these registers, which are accessible from all cores. See 3.1 [Register Descriptions and Mnemonics] for a description of MSR space and 3 [Registers] for PCI-defined configuration space. 0=NB MCA errors may be reported to the core that originated the request, if applicable and known, and the NB MCA registers in MSR space are accessible from any core.</p> <p>Note:</p> <ul style="list-style-type: none"> When the CPU which originated the request is known, it is stored in MSR0000_0411[ErrCoreId], regardless of the setting of NbMcaToMstCpuEn. See Table 231 for errors where ErrCoreId is known. If IO originated the request, then the error is reported to the NBC, regardless of the setting of NbMcaToMstCpuEn.
26	FlagMcaCorrErr: correctable error MCA exception enable. Read-write. Reset: 0. 1=Raise a machine check exception for correctable and deferred machine check errors which are enabled in D18F3x40 .

25	DisPciCfgCpuErrRsp: PCI configuration CPU error response disable. Read-write. Reset: 0. 1=Disables generation of an error response to the core on detection of a master abort, target abort, or data error condition, and disables logging and reporting through the MCA error-reporting banks for PCI configuration accesses. For NB WDT errors on PCI configuration accesses, this prevents sending an error response to the core, but does not affect logging and reporting of the NB WDT error. See D18F3x180 [DisPciCfgCpuMstAbortRsp], which applies only to master aborts.										
24	IoRdDatErrEn: IO read data error log enable. Read-write. Reset: 0. 1=Enables MCA logging and reporting of errors on transactions from IO devices upon detection of a target abort, master abort, or data error condition. 0=Errors on transactions from IO devices are not logged in MCA, although error responses to the requesting IO device may still be generated.										
23	ChipKillEccCap: chip-kill ECC mode. Read-only; updated-by-hardware. Reset: 0. 1=Chipkill ECC mode capable; ECC checking is based on x8 ECC symbols (D18F3x180 [EccSymbolSize]) and can be used for chipkill. 0=Chipkill ECC mode not capable; ECC checking is based on two interleaved, unganged 64/8-bit data/ECC lines and x4 ECC symbols and cannot be used for chipkill. See 2.16.2 [DRAM ECC Considerations] .										
22	DramEccEn: DRAM ECC enable. Read-write. Reset: 0. 1=Enables ECC check/correct mode. This bit must be set in order for ECC checking/correcting by the NB to be enabled. If set, ECC is checked and correctable errors are corrected irrespective of whether machine check ECC reporting is enabled. The hardware only allows values to be programmed into this field which are consistent with the ECC capabilities of the device as specified in D18F3xE8 [Northbridge Capabilities]. Attempts to write values inconsistent with the capabilities results in this field not being updated. This bit does not affect ECC checking in the northbridge arrays.										
21	SyncFloodOnAnyUcErr: sync flood on any UC error. Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood of all links with sync packets on detection of any NB MCA error that is uncorrectable, including northbridge array errors and link protocol errors.										
20	SyncFloodOnWDT: sync flood on watchdog timer error. Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood of all links with sync packets on detection of a watchdog timer error.										
19:18	<p>GenSubLinkSel: sublink select for CRC error generation. Read-write. Reset: 0. Selects the sublink of a link selected by GenLinkSel to be used for CRC error injection through GenCrcErrByte0 and GenCrcErrByte1. When the link is ganged, GenSubLinkSel must be 00b. When the link is unganged, the following values indicate which sublink is selected:</p> <table> <thead> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> </thead> <tbody> <tr> <td>00b</td><td>Sublink 0</td></tr> <tr> <td>01b</td><td>Sublink 1</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </tbody> </table>	<u>Bits</u>	<u>Description</u>	00b	Sublink 0	01b	Sublink 1	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Description</u>										
00b	Sublink 0										
01b	Sublink 1										
10b	Reserved										
11b	Reserved										
17	GenCrcErrByte1: generate CRC error on byte lane 1. Read-write. Reset: 0. 1=For ganged links (see GenSubLinkSel), a CRC error is injected on byte lane 1 of the link specified by GenLinkSel. For ganged links in retry mode or unganged links, this field is reserved, and GenCrcErrByte0 must be used. The data carried by the link is unaffected. This bit is cleared after the error has been generated.										
16	GenCrcErrByte0: generate CRC error on byte lane 0. Read-write. Reset: 0. 1=Causes a CRC error to be injected on byte lane 0 of the link specified by GenLinkSel and the sublink specified by GenSubLinkSel. The data carried by the link is unaffected. This bit is cleared after the error has been generated.										

15:14	<p>GenLinkSel: link select for CRC error generation. Read-write. Reset: 00b. Selects the link to be used for CRC error injection through GenCrcErrByte1/GenCrcErrByte0.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>link 0</td></tr> <tr> <td>01b</td><td>link 1</td></tr> <tr> <td>10b</td><td>link 2</td></tr> <tr> <td>11b</td><td>link 3</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	link 0	01b	link 1	10b	link 2	11b	link 3														
<u>Bits</u>	<u>Description</u>																								
00b	link 0																								
01b	link 1																								
10b	link 2																								
11b	link 3																								
13:12	<p>WDTBaseSel: watchdog timer time base select. Read-write. Reset: 0. Selects the time base used by the watchdog timer. The counter selected by WDTCntSel determines the maximum count value in the time base selected by WDTBaseSel.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>1.31 ms</td></tr> <tr> <td>01b</td><td>1.28 us</td></tr> <tr> <td>10b</td><td>Reserved.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	1.31 ms	01b	1.28 us	10b	Reserved.	11b	Reserved.														
<u>Bits</u>	<u>Description</u>																								
00b	1.31 ms																								
01b	1.28 us																								
10b	Reserved.																								
11b	Reserved.																								
11:9	<p>WDTCntSel[2:0]: watchdog timer count select bits[2:0]. Read-write. Reset: 0. Selects the count used by the watchdog timer. WDTCntSel = {D18F3x180[WDTCntSel[3]], D18F3x44[WDTCntSel[2:0]]}. The counter selected by WDTCntSel determines the maximum count value in the time base selected by WDTBaseSel. WDTCntSel is encoded as:</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0000b</td><td>4095</td></tr> <tr> <td>0001b</td><td>2047</td></tr> <tr> <td>0010b</td><td>1023</td></tr> <tr> <td>0011b</td><td>511</td></tr> <tr> <td>0100b</td><td>255</td></tr> <tr> <td>0101b</td><td>127</td></tr> <tr> <td>0110b</td><td>63</td></tr> <tr> <td>0111b</td><td>31</td></tr> <tr> <td>1000b</td><td>8191</td></tr> <tr> <td>1001b</td><td>16383</td></tr> <tr> <td>1111b-1010b</td><td>Reserved</td></tr> </table> <p>Because WDTCntSel is split between two registers, care must be taken when programming WDTCntSel to ensure that a reserved value is never used by the watchdog timer or undefined behavior could result.</p>	<u>Bits</u>	<u>Description</u>	0000b	4095	0001b	2047	0010b	1023	0011b	511	0100b	255	0101b	127	0110b	63	0111b	31	1000b	8191	1001b	16383	1111b-1010b	Reserved
<u>Bits</u>	<u>Description</u>																								
0000b	4095																								
0001b	2047																								
0010b	1023																								
0011b	511																								
0100b	255																								
0101b	127																								
0110b	63																								
0111b	31																								
1000b	8191																								
1001b	16383																								
1111b-1010b	Reserved																								
8	<p>WDTDis: watchdog timer disable. Read-write. Cold reset: 0. 1=Disables the watchdog timer. The watchdog timer is enabled by default and checks for NB system accesses for which a response is expected and where no response is received. If such a condition is detected the outstanding access is completed by generating an error response back to the requestor. An MCA error may also be generated if enabled in D18F3x40 [MCA NB Control].</p>																								
7	<p>IoErrDis: IO error response disable. Read-write. Reset: 0. 1=Disables setting either Error bit in link response packets to IO devices on detection of a target or master abort error condition.</p>																								
6	<p>CpuErrDis: CPU error response disable. Read-write. Reset: 0. BIOS: 1. 1=Disables generation of a read data error response to the core on detection of a target or master abort error condition.</p>																								
5	<p>IoMstAbortDis: IO master abort error response disable. Read-write. Reset: 0. 1=Signals target abort instead of master abort in link response packets to IO devices on detection of a master abort error condition. When IoMstAbortDis and D18F3x180[ChgMstAbortToNoErr] are both set, D18F3x180[ChgMstAbortToNoErr] takes precedence.</p>																								

4	SyncPktPropDis: sync packet propagation disable. Read-write. Reset: 0. BIOS: 0. 1=Disables flooding of all outgoing links with sync packets when a sync packet is detected on an incoming link. Sync packets are propagated by default.
3	SyncPktGenDis: sync packet generation disable. Read-write. Reset: 0. BIOS: 0. 1=Disables flooding of all outgoing links with sync packets when a CRC error is detected on an incoming link. By default, sync packet generation for CRC errors is controlled through D18F0x[E4,C4,A4,84] [Link Control].
2	SyncFloodOnDramUcEcc: sync flood on uncorrectable DRAM ECC error. Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood of all links with sync packets on detection of an uncorrectable DRAM ECC error.
1	CpuRdDatErrEn: CPU read data error log enable. Read-write. Reset: 0. 1=Enables reporting of read data errors (master aborts and target aborts) for data destined for the CPU on this node. This bit should be clear if read data error logging is enabled for the remaining error reporting blocks in the CPU. Logging the same error in more than one block may cause a single error event to be treated as a multiple error event and cause the CPU to enter shutdown.
0	Reserved.

D18F3x48 MCA NB Status Low

Bits	Description
31:0	MSR0000_0411 [31:0] is an alias of D18F3x48 . See MSR0000_0411 .

D18F3x4C MCA NB Status High

Bits	Description
31:0	MSR0000_0411 [63:32] is an alias of D18F3x4C . See MSR0000_0411 .

D18F3x50 MCA NB Address Low

Bits	Description
31:0	MSR0000_0412 [31:0] is an alias of D18F3x50 . See MSR0000_0412 [31:0].

D18F3x54 MCA NB Address High

Bits	Description
31:0	MSR0000_0412 [63:32] is an alias of D18F3x54 . See MSR0000_0412 [63:32].

D18F3x58 Scrub Rate Control

This register specifies the ECC sequential scrubbing rate for lines of memory and cache. See 2.8.3 [[Memory Scrubbers](#)]. Scrub rates are a platform consideration. See 2.16.1.8 [[Scrub Rate Considerations](#)].

Bits	Description																																																																				
31:29	Reserved.																																																																				
28:24	Reserved.																																																																				
23:5	Reserved.																																																																				
4:0	DramScrub: DRAM scrub rate. Read-write. Reset: 00000b. Specifies time between 64 B scrub events. See D18F3x5C and D18F3x60 . <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>00h</td><td>Disable sequential scrubbing</td><td>10h</td><td>1.31 ms</td></tr><tr><td>01h</td><td>40 ns¹</td><td>11h</td><td>2.62 ms</td></tr><tr><td>02h</td><td>80 ns¹</td><td>12h</td><td>5.24 ms</td></tr><tr><td>03h</td><td>160 ns¹</td><td>13h</td><td>10.49 ms</td></tr><tr><td>04h</td><td>320 ns¹</td><td>14h</td><td>20.97 ms</td></tr><tr><td>05h</td><td>640 ns</td><td>15h</td><td>42 ms</td></tr><tr><td>06h</td><td>1.28 us</td><td>16h</td><td>84 ms</td></tr><tr><td>07h</td><td>2.56 us</td><td>1Eh-17h</td><td>Reserved</td></tr><tr><td>08h</td><td>5.12 us</td><td>1Fh</td><td>Reserved</td></tr><tr><td>09h</td><td>10.2 us</td><td></td><td></td></tr><tr><td>0Ah</td><td>20.5 us</td><td></td><td></td></tr><tr><td>0Bh</td><td>41.0 us</td><td></td><td></td></tr><tr><td>0Ch</td><td>81.9 us</td><td></td><td></td></tr><tr><td>0Dh</td><td>163.8 us</td><td></td><td></td></tr><tr><td>0Eh</td><td>327.7 us</td><td></td><td></td></tr><tr><td>0Fh</td><td>655.4 us</td><td></td><td></td></tr></table> Note: <ol style="list-style-type: none">This setting is not supported except as a DRAM scrub rate when no other memory accesses are being performed.	Bits	Description	Bits	Description	00h	Disable sequential scrubbing	10h	1.31 ms	01h	40 ns ¹	11h	2.62 ms	02h	80 ns ¹	12h	5.24 ms	03h	160 ns ¹	13h	10.49 ms	04h	320 ns ¹	14h	20.97 ms	05h	640 ns	15h	42 ms	06h	1.28 us	16h	84 ms	07h	2.56 us	1Eh-17h	Reserved	08h	5.12 us	1Fh	Reserved	09h	10.2 us			0Ah	20.5 us			0Bh	41.0 us			0Ch	81.9 us			0Dh	163.8 us			0Eh	327.7 us			0Fh	655.4 us		
Bits	Description	Bits	Description																																																																		
00h	Disable sequential scrubbing	10h	1.31 ms																																																																		
01h	40 ns ¹	11h	2.62 ms																																																																		
02h	80 ns ¹	12h	5.24 ms																																																																		
03h	160 ns ¹	13h	10.49 ms																																																																		
04h	320 ns ¹	14h	20.97 ms																																																																		
05h	640 ns	15h	42 ms																																																																		
06h	1.28 us	16h	84 ms																																																																		
07h	2.56 us	1Eh-17h	Reserved																																																																		
08h	5.12 us	1Fh	Reserved																																																																		
09h	10.2 us																																																																				
0Ah	20.5 us																																																																				
0Bh	41.0 us																																																																				
0Ch	81.9 us																																																																				
0Dh	163.8 us																																																																				
0Eh	327.7 us																																																																				
0Fh	655.4 us																																																																				

D18F3x5C DRAM Scrub Address Low

In addition to sequential DRAM scrubbing, the DRAM scrubber has a redirect mode for scrubbing DRAM locations accessed during normal operation. This is enabled by setting [D18F3x5C](#)[ScrubReDirEn]. When a DRAM read is generated by any agent other than the DRAM scrubber, correctable ECC errors are corrected as the data is passed to the requestor, but the data in DRAM is not corrected if redirect scrubbing mode is disabled. In scrubber redirect mode, correctable errors detected during normal DRAM read accesses redirect the scrubber to the location of the error. After the scrubber corrects the location in DRAM, it resumes scrubbing from where it left off. DRAM scrub address registers are not modified by the redirect scrubbing mode. Sequential scrubbing and scrubber redirection can be enabled independently or together. ECC errors detected by the scrubber are logged in the MCA registers (See [D18F3x40](#) [MCA NB Control]).

Bits	Description
31:6	ScrubAddr[31:6]: DRAM scrubber address bits[31:6]. Read-write; updated-by-hardware. ScrubAddr[47:6] = {D18F3x60[ScrubAddr[47:32]], ScrubAddr[31:6]}. Reset: 0. ScrubAddr points to a DRAM cacheline in physical address space. BIOS should initialize the scrubber address register to the base address of the node specified by D18F1x[17C:140,7C:40] [DRAM Base/Limit] prior to enabling sequential scrubbing through D18F3x58[DrumScrub]. When sequential scrubbing is enabled: it starts at the address that the scrubber address registers are initialized to; it increments through address space and updates the scrubber address registers as it does so; when the scrubber reaches the DRAM limit address specified by D18F1x[17C:140,7C:40], it wraps around to the base address. Reads of the scrubber address registers provide the next cacheline to be scrubbed.
5:1	Reserved.
0	ScrubReDirEn: DRAM scrubber redirect enable. Read-write. Reset: 0. If a correctable error is discovered from a non-scrubber DRAM read, then the data is corrected before it is returned to the requestor; however, the DRAM location may be left in a corrupted state (until the next time the scrubber address counts up to that location, if sequential scrubbing is enabled through D18F3x58[DrumScrub]). 1=Enables the scrubber to immediately scrub any address in which a correctable error is discovered. This bit and sequential scrubbing can be enabled independently or together; if both are enabled, the scrubber jumps from the scrubber address to where the correctable error was discovered, scrubs that location, and then jumps back to where it left off; the scrubber address register is not affected during scrubber redirection.

D18F3x60 DRAM Scrub Address High

Bits	Description
31:16	Reserved.
15:0	ScrubAddr[47:32]: DRAM scrubber address bits[47:32]. See: D18F3x5C[ScrubAddr[31:6]]. Reset: 0.

D18F3x64 Hardware Thermal Control (HTC)

See 2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)]. If D18F3xE8[HtcCapable]=0 then this register is reserved.

Bits	Description
31	Reserved.
30:28	HtcPstateLimit: HTC P-state limit select. Read-write. Reset: Product-specific. Specifies the P-state limit of all cores when in the HTC-active state. This field uses hardware P-state numbering and is not changed on a write if the value written is greater than D18F3xDC[HwPstateMaxVal] or less than D18F4x15C[NumBoostStates]. See 2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)] and 2.5.3.1.1.2 [Hardware P-state Numbering] .

27:24	HtcHystLmt: HTC hysteresis. Read-write. Reset: Product-specific. The processor exits the HTC-active state when $(Tctl < (HtcTmpLmt - HtcHystLmt))$. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0</td></tr> <tr> <td>1h</td><td>0.5</td></tr> <tr> <td>Eh-2h</td><td>$<HtcHystLmt * 0.5>$</td></tr> <tr> <td>Fh</td><td>7.5</td></tr> </table>	Bits	Description	0h	0	1h	0.5	Eh-2h	$<HtcHystLmt * 0.5>$	Fh	7.5
Bits	Description										
0h	0										
1h	0.5										
Eh-2h	$<HtcHystLmt * 0.5>$										
Fh	7.5										
23	HtcSlewSel: HTC slew-controlled temperature select. Read-write. Reset: 0. 1=HTC logic is driven by the slew-controlled temperature, Tctl, specified in D18F3xA4 [Reported Temperature Control] . 0=HTC logic is driven by the measured control temperature with no slew controls.										
22:16	HtcTmpLmt: HTC temperature limit. Read-write. Reset: Product-specific. The processor enters the HTC-active state when Tctl reaches or exceeds the temperature limit defined by this register. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>52</td></tr> <tr> <td>01h</td><td>52.5</td></tr> <tr> <td>7Eh-02h</td><td>$<(HtcTmpLmt * 0.5) + 52>$</td></tr> <tr> <td>7Fh</td><td>115.5</td></tr> </table>	Bits	Description	00h	52	01h	52.5	7Eh-02h	$<(HtcTmpLmt * 0.5) + 52>$	7Fh	115.5
Bits	Description										
00h	52										
01h	52.5										
7Eh-02h	$<(HtcTmpLmt * 0.5) + 52>$										
7Fh	115.5										
15:8	Reserved.										
7	PslApicLoEn: P-state limit lower value change APIC interrupt enable. Read-write. Reset: 0. PslApicLoEn and PslApicHiEn enable interrupts using APIC330 [LVT Thermal Sensor] of each core when the active P-state limit in MSRC001_0061 [CurPstateLimit] changes. PslApicLoEn enables the interrupt when the limit value becomes lower (indicating higher performance). PslApicHiEn enables the interrupt when the limit value becomes higher (indicating lower performance). 1=Enable interrupt.										
6	PslApicHiEn: P-state limit higher value change APIC interrupt enable. Read-write. Reset: 0. See PslApicLoEn.										
5	HtcActSts: HTC-active status. Read; set-by-hardware; write-1-to-clear. Reset: 0. This bit is set by hardware when the processor enters the HTC-active state. It is cleared by writing a 1 to it.										
4	HtcAct: HTC-active state. Read-only, updated-by-hardware. Reset: X. . 1=The processor is currently in the HTC-active state. 0=The processor is not in the HTC-active state.										
3:1	Reserved.										
0	HtcEn: HTC enable. Read-write. Reset: 0. BIOS: IF (D18F3x64 [HtcTmpLmt] ==0) THEN 0 ELSE 1 ENDIF. 1=HTC is enabled; the processor is capable of entering the HTC-active state.										

D18F3x68 Software P-state Limit

See [2.10.3.2 \[Software P-state Limit Control\]](#). If [D18F3xE8 \[HtcCapable\]](#)=0 then this register is reserved.

Bits	Description
31	Reserved.
30:28	SwPstateLimit: software P-state limit select. Read-write. Reset: Product-specific. Specifies a P-state limit for all cores. Uses hardware P-state numbering; see 2.5.3.1.1.2 [Hardware P-state Numbering] . Not changed on a write if the value written is greater than D18F3xDC [HwPstateMaxVal] or less than D18F4x15C [NumBoostStates] . See SwPstateLimitEn.
27:6	Reserved.

5	SwPstateLimitEn: software P-state limit enable. Read-write. Reset: 0. 1=SwPstateLimit is enabled.
4:0	Reserved.

D18F3x6C Data Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:
 - [D18F3x6C\[UpRspDBC\]](#) ≥ 1 .
 - [D18F3x6C\[DnReqDBC\]](#) ≥ 1 .
 - [D18F3x6C\[UpReqDBC\]](#) ≥ 1 .
 - [D18F3x6C\[DnRspDBC\]](#) ≥ 1 .
- If [D18F0x\[E4,C4,A4,84\]\[IsocEn\]](#)=1: [IsocRspDBC](#) ≥ 1 .
- The total number of data buffers allocated in this register and [D18F3x7C](#) must satisfy the following equation:

$$\begin{aligned} & \text{D18F3x6C[UpReqDBC]} + \text{D18F3x6C[UpRspDBC]} + \text{D18F3x6C[DnReqDBC]} + \\ & \text{D18F3x6C[DnRspDBC]} + \text{D18F3x6C[IsocRspDBC]} + (\text{IF } (\text{D18F3x7C[Sri2XbarFreeRspDBC]}==0) \\ & \text{THEN } (\text{D18F3x7C[Sri2XbarFreeXreqDBC]}*2) \text{ ELSE } \text{D18F3x7C[Sri2XbarFreeXreqDBC]} \text{ ENDIF}) + \\ & \text{D18F3x7C[Sri2XbarFreeRspDBC]} \leq 16. \end{aligned}$$

Bits	Description
31	Reserved.
30:28	IsocRspDBC: isochronous response data buffer count. Read-write. Cold reset: 3. BIOS: 1.
27:19	Reserved.
18:16	UpRspDBC: upstream response data buffer count. Read-write. Cold reset: 2. BIOS: 1.
15	Reserved.
14:8	Reserved.
7:6	DnRspDBC: downstream response data buffer count. Read-write. Cold reset: 2. BIOS: 1.
5:4	DnReqDBC: downstream request data buffer count. Read-write. Cold reset: 1. BIOS: 1.
3	Reserved.
2:0	UpReqDBC: upstream request data buffer count. Read-write. Cold reset: 2. BIOS: 2.

D18F3x70 SRI to XBAR Command Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:
 - [D18F3x70\[UpRspCBC\]](#) ≥ 1 .
 - [D18F3x70\[UpPreqCBC\]](#) ≥ 1 .
 - [D18F3x70\[DnPreqCBC\]](#) ≥ 1 .
 - [D18F3x70\[UpReqCBC\]](#) ≥ 1 .
 - [D18F3x70\[DnReqCBC\]](#) ≥ 1 .
 - [D18F3x70\[DnRspCBC\]](#) ≥ 1 .
- If any of the [D18F0x\[E4,C4,A4,84\]\[IsocEn\]](#) bits are set:

IsocReqCBC >= 1 IsocRspCBC >= 1

- If **D18F0x[E4,C4,A4,84]**[IsocEn]=1 and isochronous posted requests may be generated by the system:

IsocPreqCBC >= 1

- The total number of SRI to XBAR command buffers allocated in this register and **D18F3x7C** must satisfy the following equation:

$$\begin{aligned} & \bullet \text{D18F3x70[IsocRspCBC]} + \text{D18F3x70[IsocPreqCBC]} + \text{D18F3x70[IsocReqCBC]} + \\ & \text{D18F3x70[UpRspCBC]} + \text{D18F3x70[DnPreqCBC]} + \text{D18F3x70[UpPreqCBC]} + \\ & \text{D18F3x70[DnReqCBC]} + \text{D18F3x70[DnRspCBC]} + \text{D18F3x70[UpReqCBC]} + \\ & \text{D18F3x7C[Sri2XbarFreeRspCBC]} + \text{D18F3x7C[Sri2XbarFreeXreqCBC]} \leq 24. \end{aligned}$$

Bits	Description
31	Reserved.
30:28	IsocRspCBC: isoc response command buffer count. Read-write. Cold reset: 1. BIOS: 1.
27	Reserved.
26:24	IsocPreqCBC: isoc posted request command buffer count. Read-write. Cold reset: 1. BIOS: 0.
23	Reserved.
22:20	IsocReqCBC: isoc request command buffer count. Read-write. Cold reset: 1. BIOS: 1.
19	Reserved.
18:16	UpRspCBC: upstream response command buffer count. Read-write. Cold reset: 1. BIOS: 3.
15	Reserved.
14:12	DnPreqCBC: downstream posted request command buffer count. Read-write. Cold reset: 2. BIOS: 1.
11	Reserved.
10:8	UpPreqCBC: upstream posted request command buffer count. Read-write. Cold reset: 1. BIOS: 1.
7:6	DnRspCBC: downstream response command buffer count. Read-write. Cold reset: 1. BIOS: 1.
5:4	DnReqCBC: downstream request command buffer count. Read-write. Cold reset: 1. BIOS: 1.
3	Reserved.
2:0	UpReqCBC: upstream request command buffer count. Read-write. Cold reset: 3. BIOS: 3

D18F3x74 XBAR to SRI Command Buffer Count

Cold reset: 0007_1111h. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use **D18F0x6C**[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

Table 184: Buffer Definitions

Term	Definition
SpqSize	Probe command queue size. SpqSize = 20.
SrqSize	SRQ (XBAR command and probe response to SRI) queue size. SrqSize = 36.

Table 184: Buffer Definitions

Term	Definition
PrbRsp	SRQ entries hard allocated to probe responses. PrbRsp = 4.
MpbcSize	MPB command buffer size. MpbcSize = 24.
McqSize	MCT command queue size. McqSize = 36.

- To ensure deadlock free operation the following minimum buffer allocations are required:
 - $D18F3x74[ProbeCBC] \geq 2$.
 - $D18F3x74[UpReqCBC] \geq 1$.
 - $D18F3x74[UpPreqCBC] \geq 1$.
 - $(IsocReqCBC + IsocPreqCBC + DRReqCBC) \leq 31$.
 - $(IsocReqCBC + IsocPreqCBC + DRReqCBC) \leq (McqSize - 16)$.
- If any of $D18F0x[E4,C4,A4,84][IsocEn]$ bits are set, then $IsocReqCBC \geq 1$.
- If any of the $D18F0x[E4,C4,A4,84][IsocEn]$ bits are set and isochronous posted requests may be generated by the system:
 $IsocPreqCBC \geq 1$
- The total number of XBAR to SRI command buffers allocated in this register and $D18F3x7C$ must satisfy the following equation:
 - $D18F3x74[UpReqCBC] + D18F3x74[UpPreqCBC] + D18F3x74[DnReqCBC] + D18F3x74[DnPreqCBC] + D18F3x74[IsocReqCBC] + D18F3x74[IsocPreqCBC] + D18F3x74[DRReqCBC] + D18F3x7C[Xbar2SriFreeListCBC] + (D18F3x1A0[CpuCmdBufCnt] * NumOfL2Complexes) + D18F3x1A0[CpuToNbFreeBufCnt] + PrbRsp \leq SrlSize$
- The total number of SPQ (probe command) buffers allocated must satisfy the following equation:
 - $(D18F3x17C[SPQPrbFreeCBC] + D18F3x74[ProbeCBC]) \leq SpqSize$.

Bits	Description								
31:28	DRReqCBC: display refresh request command buffer count. Read-write. BIOS: 0.								
27	Reserved.								
26:24	IsocPreqCBC: isochronous posted request command buffer count. Read-write. BIOS: 1.								
23:20	IsocReqCBC: isochronous request command buffer count. Read-write. BIOS: 1.								
19:16	ProbeCBC: probe command buffer count. Read-write. BIOS: Ch. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 buffers</td></tr> <tr> <td>Ch-1h</td><td><ProbeCBC> buffers</td></tr> <tr> <td>Fh-Dh</td><td>Reserved.</td></tr> </table>	Bits	Description	0h	0 buffers	Ch-1h	<ProbeCBC> buffers	Fh-Dh	Reserved.
Bits	Description								
0h	0 buffers								
Ch-1h	<ProbeCBC> buffers								
Fh-Dh	Reserved.								
15	Reserved.								

14:12	DnPreqCBC: downstream posted request command buffer count. Read-write. BIOS: 0.
11	Reserved.
10:8	UpPreqCBC: upstream posted request command buffer count. Read-write. BIOS: 1.
7	Reserved.
6:4	DnReqCBC: downstream request command buffer count. Read-write. BIOS: 0.
3	Reserved.
2:0	UpReqCBC: upstream request command buffer count. Read-write. BIOS: 1.

D18F3x78 MCT to XBAR Buffer Count

Cold Reset: 0024_0519h. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:
 $\text{ProbeCBC} \geq 1$ $\text{RspCBC} \geq 1$ $\text{RspDBC} \geq 2$
 $\text{RspDBC} \geq \text{D18F2x11C}[\text{MctPrefReqLimit}] + 2$
- The total number of command buffers allocated in this register must satisfy the following equation:
 $(\text{D18F3x78}[\text{ProbeCBC}] + \text{D18F3x78}[\text{RspCBC}]) \leq \text{MpbcsSize}.$

Bits	Description												
31:22	Reserved.												
21:16	RspDBC: response data buffer count. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>02h</td><td>2 Buffers</td></tr> <tr> <td>1Fh-03h</td><td><RspDBC> Buffers</td></tr> <tr> <td>20h</td><td>32 Buffers</td></tr> <tr> <td>3Fh-21h</td><td>Reserved</td></tr> </table>	Bits	Description	01h-00h	Reserved	02h	2 Buffers	1Fh-03h	<RspDBC> Buffers	20h	32 Buffers	3Fh-21h	Reserved
Bits	Description												
01h-00h	Reserved												
02h	2 Buffers												
1Fh-03h	<RspDBC> Buffers												
20h	32 Buffers												
3Fh-21h	Reserved												
15:13	Reserved.												
12:8	ProbeCBC: probe command buffer count. Read-write. BIOS: 8h.												
7:6	Reserved.												
5:0	RspCBC: response command buffer count. Read-write. BIOS: 10h.												

D18F3x7C Free List Buffer Count

Cold Reset: 0003_660Ch. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values. See [D18F3x6C](#) and [D18F3x70](#).

- To ensure deadlock free operation the following minimum buffer allocations are required:
 - IF ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)==0) THEN ([D18F3x7C\[Sri2XbarFreeXreqCBC\]](#)>2).
 - IF ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)!=0) THEN ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)>2).
 - IF ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)==0) THEN ([D18F3x7C\[Sri2XbarFreeXreqDBC\]](#)>2).
 - IF ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)!=0) THEN ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)>2).
 - [D18F3x7C\[Xbar2SriFreeListCBC\]](#) >= ([D18F3x1A0\[CpuToNbFreeBufCnt\]](#) * [NumOfL2Complexes](#)) + 2.

Bits	Description
31	Reserved.
30:28	Xbar2SriFreeListCBInc: XBAR to SRI free list command buffer increment. Read-write. This field is use to add buffers to the free list pool if they are reclaimed from hard allocated entries without having to go through warm reset. This field may only be programmed after buffers have been allocated and released via D18F0x6C[RlsLnkFullTokCntImm] .
27:23	Reserved.
22:20	Sri2XbarFreeRspDBC: SRI to XBAR free response data buffer count. Read-write. BIOS: 0.
19:16	Sri2XbarFreeXreqDBC: SRI to XBAR free request and posted request data buffer count. Read-write. BIOS: 5h. If Sri2XbarFreeRspDBC =0h, then these buffers are shared between requests, responses and posted requests and the number of buffers allocated is two times the value of this field.
15:12	Sri2XbarFreeRspCBC: SRI to XBAR free response command buffer count. Read-write. BIOS: 0h.
11:8	Sri2XbarFreeXreqCBC: SRI to XBAR free request and posted request command buffer count. Read-write. BIOS: 6h. If Sri2XbarFreeRspCBC =0h, then these buffers are shared between requests, responses and posted requests and the number of buffers allocated is two times the value of this field.
7:6	Reserved.
5:0	Xbar2SriFreeListCBC: XBAR to SRI free list command buffer count. Read-write. BIOS: 1Bh.

D18F3x[84:80] ACPI Power State Control

This block consists of eight identical 8-bit registers, one for each System Management Action Field (SMAF) code associated with STPCLK assertion commands from the link. Refer to the descriptions below for the associated ACPI state and system management actions for each of the 8 SMAF codes. The SmafAct fields specify the system management actions taken when the corresponding SMAF code is received. For instance, a SMAF code of 5 results in the power management actions specified by SmafAct5. Some ACPI states and associated SMAF codes may not be supported in certain conditions. See [2.5 \[Power Management\]](#) for which states are supported.

When a link STPCLK assertion command is received by the processor, the power management commands specified by the register with the corresponding SMAF code are invoked. When the STPCLK deassertion command is received by the processor, the processor returns into the operational state.

In multi-node systems, these registers should be programmed identically in all nodes.

Table 185: SMAF Action Definition

Register	SmafAct	ACPI state	Description
D18F3x84 [31:24]	SmafAct7	C1	Initiated when a Halt instruction is executed by processor. This does not involve the interaction with the SMC, therefore the SMC is required to never send STPCLK assertion commands with SMAF=7h.
D18F3x84 [23:16]	SmafAct6	S4/S5	Initiated by a processor access to the ACPI-defined PM1_CNTa register.
D18F3x84 [15:8]	SmafAct5	Throttling	Occurs based upon SMC hardware-initiated throttling. AMD recommends using PROCHOT_L for thermal throttling and not implementing stop clock based throttling.
D18F3x84 [7:0]	SmafAct4	S3	Initiated by a processor access to the ACPI-defined PM1_CNTa register.
D18F3x80 [31:24]	SmafAct3	S1	Initiated by a processor access to the ACPI-defined PM1_CNTa register.
D18F3x80 [23:16]	SmafAct2	-	
D18F3x80 [15:8]	SmafAct1	C1E, or Link init.	Initiated by an access to the ACPI-defined P_LVL3 register.
D18F3x80 [7:0]	SmafAct0	C2	Initiated by a processor access to the ACPI-defined P_LVL2 register.

D18F3x80 ACPI Power State Control Low

Reset: 0000_0000h. Read-write.

Bits	Description
31:29	ClkDivisorSmafAct3. See: ClkDivisorSmafAct0.
28:27	Reserved.
26	NbGateEnSmafAct3. See: NbGateEnSmafAct0.
25	NbLowPwrEnSmafAct3. See: NbLowPwrEnSmafAct0.
24	CpuPrbEnSmafAct3. See: CpuPrbEnSmafAct0.
23:21	ClkDivisorSmafAct2. See: ClkDivisorSmafAct0.
20:19	Reserved.
18	NbGateEnSmafAct2. See: NbGateEnSmafAct0.
17	NbLowPwrEnSmafAct2. See: NbLowPwrEnSmafAct0.
16	CpuPrbEnSmafAct2. See: CpuPrbEnSmafAct0.
15:13	ClkDivisorSmafAct1. See: ClkDivisorSmafAct0.

12:11	Reserved.																				
10	NbGateEnSmafAct1. See: NbGateEnSmafAct0.																				
9	NbLowPwrEnSmafAct1. See: NbLowPwrEnSmafAct0.																				
8	CpuPrbEnSmafAct1. See: CpuPrbEnSmafAct0.																				
7:5	ClkDivisorSmafAct0: clock divisor. Read-write. Specifies the core clock frequency while in the low-power state. This divisor is relative to the current FID frequency, or: <ul style="list-style-type: none">100 MHz * (10h + MSRC001_00[6B:64][CpuFid[5:0]]) of the current P-state specified by MSRC001_0063[CurPstate]. If MSRC001_00[6B:64] [CpuDid] of the current P-state indicates a divisor that is deeper than specified by this field, then no frequency change is made when entering the low-power state associated with this register. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>/1</td><td>100b</td><td>/16</td></tr><tr><td>001b</td><td>/2</td><td>101b</td><td>/128</td></tr><tr><td>010b</td><td>/4</td><td>110b</td><td>/512</td></tr><tr><td>011b</td><td>/8</td><td>111b</td><td>Turn off clocks</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	000b	/1	100b	/16	001b	/2	101b	/128	010b	/4	110b	/512	011b	/8	111b	Turn off clocks
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																		
000b	/1	100b	/16																		
001b	/2	101b	/128																		
010b	/4	110b	/512																		
011b	/8	111b	Turn off clocks																		
4:3	Reserved.																				
2	NbGateEnSmafAct0: northbridge gate enable. Read-write. This bit does not control hardware. NbLowPwrEn is required to be set if this bit is set.																				
1	NbLowPwrEnSmafAct0: Northbridge low-power enable. Read-write. 1=The NB clock is ramped down to the divisor specified by D18F3xD4 [NbClkDiv] and DRAM is placed into self-refresh mode when LDTSTOP_L is asserted while in the low-power state.																				
0	CpuPrbEnSmafAct0: CPU direct probe enable. Read-write. Specifies how probes are handled while in the low-power state. 0=When the probe request comes into the NB, the core clock is brought up to the COF (based on the current P-state), all outstanding probes are completed, the core waits for a hysteresis time based on D18F3xD4 [ClkRampHystSel], and then the core clock is brought down to the frequency specified by ClkDivisor. 1=The core clock does not change frequency; the probe is handled at the frequency specified by ClkDivisor; this may only be set if: <ul style="list-style-type: none">ClkDivisor specifies a divide-by 1, 2, 4, 8, or 16 and NbCof <= 3.2 GHzClkDivisor specifies a divide-by 1, 2, 4, or 8 and NbCof >= 3.4 GHz This bit also specifies functionality of the timer used for cache flushing during halt. See D18F3xDC [CacheFlushOnHaltTmr]. <ul style="list-style-type: none">If ((D18F3x84[CpuPrbEnSmafAct7]==0) && (D18F3xDC[IgnCpuPrbEn]==0)), only the time when the core is halted and has its clocks ramped up to service probes is counted.If ((D18F3x84[CpuPrbEnSmafAct7]==1) or (D18F3xDC[IgnCpuPrbEn]==1)), all of the time the core is halted is counted.																				

D18F3x84 ACPI Power State Control High

Reset: 0000_0000h. Read-write.

Bits	Description
31:29	ClkDivisorSmafAct7. See: D18F3x80 [ClkDivisorSmafAct0].
28:27	Reserved.
26	NbGateEnSmafAct7. See: D18F3x80 [NbGateEnSmafAct0].
25	NbLowPwrEnSmafAct7. See: D18F3x80 [NbLowPwrEnSmafAct0].

24	CpuPrbEnSmafAct7. See: D18F3x80 [CpuPrbEnSmafAct0].
23:21	ClkDivisorSmafAct6. See: D18F3x80 [ClkDivisorSmafAct0].
20:19	Reserved.
18	NbGateEnSmafAct6. See: D18F3x80 [NbGateEnSmafAct0].
17	NbLowPwrEnSmafAct6. See: D18F3x80 [NbLowPwrEnSmafAct0].
16	CpuPrbEnSmafAct6. See: D18F3x80 [CpuPrbEnSmafAct0].
15:13	ClkDivisorSmafAct5. See: D18F3x80 [ClkDivisorSmafAct0].
12:11	Reserved.
10	NbGateEnSmafAct5. See: D18F3x80 [NbGateEnSmafAct0].
9	NbLowPwrEnSmafAct5. See: D18F3x80 [NbLowPwrEnSmafAct0].
8	CpuPrbEnSmafAct5. See: D18F3x80 [CpuPrbEnSmafAct0].
7:5	ClkDivisorSmafAct4. See: D18F3x80 [ClkDivisorSmafAct0].
4:3	Reserved.
2	NbGateEnSmafAct4. See: D18F3x80 [NbGateEnSmafAct0].
1	NbLowPwrEnSmafAct4. See: D18F3x80 [NbLowPwrEnSmafAct0]. BIOS: 1.
0	CpuPrbEnSmafAct4. See: D18F3x80 [CpuPrbEnSmafAct0].

D18F3x88 NB Configuration 1 Low (NB_CFG1_LO)

Bits	Description
31:0	MSRC001_001F [31:0] is an alias of D18F3x88 . See MSRC001_001F .

D18F3x8C NB Configuration 1 High (NB_CFG1_HI)

Bits	Description
31:0	MSRC001_001F [63:32] is an alias of D18F3x8C . See MSRC001_001F .

D18F3xA0 Power Control Miscellaneous

Bits	Description
31	CofVidProg: COF and VID of P-states programmed. Read-only. Reset: Product-specific. 1=Out of cold reset, the VID, FID, and DID values of the P-state registers specified by MSRC001_0071 [StartupPstate] and D18F5x174 [StartupNbPstate] have been applied to the processor. 0=Out of cold reset, the boot VID is applied to all processor power planes, the NB clock plane is set to 800 MHz (with a FID of 00h=800 MHz and a DID of 0b) and core CPU clock planes are set to 800 MHz (with a FID of 00h=1.6 GHz and a DID of 1h). Registers containing P-state information such as FID, DID, and VID values are valid out of cold reset independent of the state of D18F3xA0 [CofVidProg]. BIOS must transition the processor to a valid P-state out of cold reset when D18F3xA0 [CofVidProg]=0. See 2.5.3.1.6 [BIOS Requirements for Core P-state Initialization and Transitions] .
30:28	Reserved.

27:16	ConfigId: Configuration identifier. Read-only. Reset: Product-specific. Specifies the configuration ID associated with the product.																							
15	Reserved.																							
14	Svi2HighFreqSel: SVI2 high frequency select. Read-write. Cold reset: 0. BIOS: 1. 0=3.4 MHz. 1=20 MHz. Writes to this field take effect at the next SVI command boundary. If 20 MHz is supported by the VRM, BIOS should program this to 1 prior to any VID transitions. Once this bit is set, it should not be cleared until the next cold reset.																							
13:11	PllLockTime: PLL synchronization lock time. Read-write. Reset: 0. BIOS: 001b. If a P-state change occurs that applies a new FID to the PLL, this field specifies the time required for the PLL to lock to the new frequency. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>1 us</td><td>100b</td><td>8 us</td></tr><tr><td>001b</td><td>2 us</td><td>101b</td><td>16 us</td></tr><tr><td>010b</td><td>3 us</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>4 us</td><td>111b</td><td>Reserved</td></tr></table>				<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	000b	1 us	100b	8 us	001b	2 us	101b	16 us	010b	3 us	110b	Reserved	011b	4 us	111b	Reserved
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																					
000b	1 us	100b	8 us																					
001b	2 us	101b	16 us																					
010b	3 us	110b	Reserved																					
011b	4 us	111b	Reserved																					
10	Reserved.																							
9	Reserved.																							
8	PsiVid[7]. Read-write. Reset: 0. BIOS: 2.5.1.3.1.1 . See PsiVid[6:0].																							
7	PsiVidEn: PSI_L VID enable. Read-write. Reset: 0. BIOS: 2.5.1.3.1.1 . This bit specifies how PSI_L is controlled. This signal may be used by the voltage regulator to improve efficiency while in reduced power states. 1=Control over the PSI_L signal is as specified by the PsiVid field of this register. 0=PSI_L is always high. See 2.5.1.3.1 [PSIx_L Bit] .																							
6:0	PsiVid[6:0]: PSI_L VID threshold. Read-write. Reset: 0. BIOS: 2.5.1.3.1.1 . PsiVid[7:0] = {PsiVid[7], PsiVid[6:0]}. When enabled by PsiVidEn, PsiVid[7:0] specifies the threshold value of the VID code generated by the processor, which in turn determines the state of PSI0_L. When the VID code generated by the processor is less than PsiVid[7:0] (i.e., the VID code is specifying a higher voltage level than the PsiVid-specified voltage level), then PSI0_L is high; when the VID code is greater than or equal to PsiVid[7:0], PSI0_L is driven low. See 2.5.1.3.1 [PSIx_L Bit] .																							

D18F3xA4 Reported Temperature Control

The slew rate controls in this register are used to filter processor temperature measurements. Separate controls are provided for a measured temperature that is higher or lower than Tctl. The per-step timer counts as long as the measured temperature stays either above or below Tctl. Each time the measured temperature changes to the other side of Tctl, the step timer resets, and Tctl is not changed. If, for example, step times are enabled in both directions, Tctl=62.625, and the measured temperature keeps jumping quickly between 62.5 and 63.0, then (assuming the step times are long enough) Tctl would not change. However, once the measured temperature settles on one side of Tctl, Tctl can step toward the measured temperature. If the difference of measured temperature minus Tctl is greater than the value set by MaxTmpDiffUp, then Tctl is set equal to the measured temperature. See [2.10 \[Thermal Functions\]](#).

Bits	Description																											
31:21	CurTmp: current temperature. IF (D18F3xA4[CurTmpTjSel]==11b) THEN Read-write. ELSE Read-only, updated-by-hardware. ENDIF. Reset: X. Provides the current control temperature, Tctl, after the slew-rate controls have been applied. RangeUnadjusted = (D18F3xA4[CurTmpTjSel]!=11b). <table><tr><th>Bits</th><th>RangeUnadjusted</th><th>Description</th></tr><tr><td>000h</td><td>0</td><td>-49</td></tr><tr><td>001h</td><td>0</td><td>-48.875</td></tr><tr><td>7FEh-002h</td><td>0</td><td><(CurTmp*0.125)-49></td></tr><tr><td>7FFh</td><td>0</td><td>206.875</td></tr><tr><td>000h</td><td>1</td><td>0</td></tr><tr><td>001h</td><td>1</td><td>0.125</td></tr><tr><td>7FEh-002h</td><td>1</td><td><CurTmp*0.125></td></tr><tr><td>7FFh</td><td>1</td><td>255.875</td></tr></table>	Bits	RangeUnadjusted	Description	000h	0	-49	001h	0	-48.875	7FEh-002h	0	<(CurTmp*0.125)-49>	7FFh	0	206.875	000h	1	0	001h	1	0.125	7FEh-002h	1	<CurTmp*0.125>	7FFh	1	255.875
Bits	RangeUnadjusted	Description																										
000h	0	-49																										
001h	0	-48.875																										
7FEh-002h	0	<(CurTmp*0.125)-49>																										
7FFh	0	206.875																										
000h	1	0																										
001h	1	0.125																										
7FEh-002h	1	<CurTmp*0.125>																										
7FFh	1	255.875																										
20	Reserved.																											
19:18	Reserved.																											
17:16	CurTmpTjSel: Current temperature select. Read-write. Reset: 00. These bits may be used for diagnostic software. <table><tr><th>Bits</th><th>Description</th></tr><tr><td>00b</td><td>CurTmp provides the read-only Tctl value.</td></tr><tr><td>01b</td><td>Reserved.</td></tr><tr><td>10b</td><td>Reserved.</td></tr><tr><td>11b</td><td>CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero.</td></tr></table>	Bits	Description	00b	CurTmp provides the read-only Tctl value.	01b	Reserved.	10b	Reserved.	11b	CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero.																	
Bits	Description																											
00b	CurTmp provides the read-only Tctl value.																											
01b	Reserved.																											
10b	Reserved.																											
11b	CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero.																											
15:13	Reserved.																											
12:8	PerStepTimeDn: per step time down. Read-write. Cold reset: 18h. BIOS: 0Fh. Specifies the time that measured temperature must remain below Tctl before applying a 0.125 downward step. See: PerStepTimeUp.																											
7	TmpSlewDnEn: temperature slew downward enable. Read-write. Cold reset: 0. BIOS: 1. 1=Downward slewing enabled. 0=Downward slewing disabled.																											
6:5	TmpMaxDiffUp: temperature maximum difference up. Read-write. Cold reset: 00b. BIOS: 11b. Specifies the maximum difference, (measured temperature - Tctl), when Tctl immediately updates to the measured temperature. <table><tr><th>Bits</th><th>Description</th></tr><tr><td>00b</td><td>0.0 (disable upward slew)</td></tr><tr><td>01b</td><td>1.0</td></tr><tr><td>10b</td><td>3.0</td></tr><tr><td>11b</td><td>9.0</td></tr></table>	Bits	Description	00b	0.0 (disable upward slew)	01b	1.0	10b	3.0	11b	9.0																	
Bits	Description																											
00b	0.0 (disable upward slew)																											
01b	1.0																											
10b	3.0																											
11b	9.0																											
4:0	PerStepTimeUp: per 1/8th degree step time up. Read-write. Cold reset: 00h. BIOS: 0Fh. Specifies the time that measured temperature must remain above Tctl before applying a 0.125 upward step. <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>1Fh-00h</td><td><(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]> ms, ranging from 1 ms to 8000 ms.</td></tr></table>	Bits	Definition	1Fh-00h	<(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]> ms, ranging from 1 ms to 8000 ms.																							
Bits	Definition																											
1Fh-00h	<(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]> ms, ranging from 1 ms to 8000 ms.																											

D18F3xA8 Pop Up and Down P-states

Bits	Description
31:29	PopDownPstate . Read-write. Reset: D18F3xDC [HwPstateMaxVal]. BIOS: D18F3xDC [HwPstateMaxVal]. Specifies the pop-down P-state number. This field uses hardware P-state numbering. See 2.5.3.2.3.3 [Core C6 (CC6) State] .
28:0	Reserved.

D18F3xB8 NB Array Address

Reset: xxxx_xxxxh. [D18F3xB8](#) [NB Array Address] and [D18F3xBC](#) [NB Array Data Port] provide a mechanism to inject errors into DRAM and data read from internal NB arrays.

[D18F3xB8](#) should first be written with the target array and address within the array. Read and write accesses to [D18F3xBC](#) then access the target address within the target array.

Bits	Description								
31:28	ArraySelect . Read-write. Selects the NB array to access. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved</td></tr> <tr> <td>8h</td><td>D18F3xBC_x8 [DRAM ECC]</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>	Bits	Description	7h-0h	Reserved	8h	D18F3xBC_x8 [DRAM ECC]	Fh-9h	Reserved
Bits	Description								
7h-0h	Reserved								
8h	D18F3xBC_x8 [DRAM ECC]								
Fh-9h	Reserved								
27:10	Reserved.								
9:0	ArrayAddress . Read-write. Selects the location to access within the selected array. This format of this field is a function of ArraySelect. <table> <tr> <th>ArraySelect</th><th>Description</th></tr> <tr> <td>8h</td><td>DRAM ECC.</td></tr> <tr> <td>All others</td><td>Reserved</td></tr> </table>	ArraySelect	Description	8h	DRAM ECC.	All others	Reserved		
ArraySelect	Description								
8h	DRAM ECC.								
All others	Reserved								

D18F3xBC NB Array Data Port

See [D18F3xB8](#) for register access information. Address: [D18F3xB8](#)[ArraySelect].

Bits	Description
31:0	Data .

D18F3xBC_x8 DRAM ECC

This register controls injection of errors in writes to DRAM. See [2.16.3.1 \[DRAM Error Injection\]](#).

Bits	Description
31:29	Reserved.

28:20	<p>ErrInjEn: enable error injection to word. Read-write. Reset: 0. Each bit in this field corresponds to a 16-bit DRAM word and enables injecting errors in that word.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[15:0]</td></tr> <tr> <td>[1]</td><td>Data[31:16]</td></tr> <tr> <td>[2]</td><td>Data[47:32]</td></tr> <tr> <td>[3]</td><td>Data[63:48]</td></tr> <tr> <td>[4]</td><td>Data[79:64]</td></tr> <tr> <td>[5]</td><td>Data[95:80]</td></tr> <tr> <td>[6]</td><td>Data[111:96]</td></tr> <tr> <td>[7]</td><td>Data[127:112]</td></tr> <tr> <td>[8]</td><td>ECC[15:0]</td></tr> </table>	Bit	Description	[0]	Data[15:0]	[1]	Data[31:16]	[2]	Data[47:32]	[3]	Data[63:48]	[4]	Data[79:64]	[5]	Data[95:80]	[6]	Data[111:96]	[7]	Data[127:112]	[8]	ECC[15:0]
Bit	Description																				
[0]	Data[15:0]																				
[1]	Data[31:16]																				
[2]	Data[47:32]																				
[3]	Data[63:48]																				
[4]	Data[79:64]																				
[5]	Data[95:80]																				
[6]	Data[111:96]																				
[7]	Data[127:112]																				
[8]	ECC[15:0]																				
19	Reserved.																				
18	DramErrEn. Read-write. Reset: 0. 1=Errors are continually injected on DRAM writes. The error injection takes place only on DRAM write accesses and should be initiated by a non-cacheable store. Errors continue to be injected on writes until this bit is cleared to a 0 by software.																				
17	EccWrReq. Read; write-1-only; cleared-by-hardware. Reset: 0. 1=Error is injected on DRAM write at the bits enabled by ErrInjEn and EccVector. A single error injection takes place on the next DRAM write access and should be initiated by a non-cacheable store. This bit is cleared by hardware after the write.																				
16	EccRdReq. Read; write-1-only; cleared-by-hardware. Reset: 0. 1=Indicates a DRAM ECC read is requested. The read takes place on the next DRAM read access and should be initiated by a non-cacheable load. The ECC bits read from DRAM are stored in EccVector. This bit is cleared by hardware after the read.																				
15:0	EccVector: error injection vector. Read-write. Reset: x. When used in conjunction with EccWrReq, each bit of EccVector enables injecting errors to the corresponding bit within each word enabled by ErrInjEn. When used in conjunction with EccRdReq, EccVector holds the contents of the DRAM ECC bits after the read.																				

D18F3xD4 Clock Power/Timing Control 0

Bits	Description
31	NbClkDivApplyAll. Read-write. Cold reset: 0. BIOS: 1. See NbClkDiv.

30:28	<p>NbClkDiv: NB clock divisor. Read-write. Cold reset: Product-specific. BIOS: 001b.</p> <p>Specifies the NB CLK divisor associated with D18F3x80/D18F3x84[NbLowPwrEn]. This divisor is applied while LDTSTOP_L is asserted if the corresponding core CLK divisor, D18F3x80/D18F3x84[ClkDivisor], is set to “turn off clocks” or if NBClkDivApplyAll=1; otherwise, the divisor specified by D18F3x80/D18F3x84[ClkDivisor] is applied. This divisor is relative to the current NB FID frequency, or:</p> <p>100 MHz * (4 + D18F5x16[C:0][NbFid[5:0]]).</p> <p>If D18F5x16[C:0][NbDid] of the current NB P-state indicates a divisor that is lower than specified by this field, then no NB frequency change is made when entering the low-power state associated with this register (i.e., if this field specifies a divide-by 1 and the DID is divide-by 2, then the divisor remains 2 while in the low-power state). This field is encoded as follows:</p> <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>Divide-by 1</td><td>100b</td><td>Divide-by 16</td></tr><tr><td>001b</td><td>Divide-by 2</td><td>101b</td><td>Reserved</td></tr><tr><td>010b</td><td>Divide-by 4</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>Divide-by 8</td><td>111b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	000b	Divide-by 1	100b	Divide-by 16	001b	Divide-by 2	101b	Reserved	010b	Divide-by 4	110b	Reserved	011b	Divide-by 8	111b	Reserved																
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																																		
000b	Divide-by 1	100b	Divide-by 16																																		
001b	Divide-by 2	101b	Reserved																																		
010b	Divide-by 4	110b	Reserved																																		
011b	Divide-by 8	111b	Reserved																																		
27:24	<p>PowerStepUp. Read-write. Cold reset: 0000b. Specifies the rate at which blocks of compute unit and NB logic are gated on while the processor transitions from a quiescent state to an active state as part of a power management state transition. There are about 15 steps in this transition for each compute unit and about 5 steps for the NB for the PowerStepDown and PowerStepUp transitions. So the total transition time for a single compute unit is about 15 times the time specified by PowerStepDown and PowerStepUp and the transition time for the NB is about 5 times the time specified by PowerStepDown and PowerStepUp. Use of longer transition times may help reduce voltage transients associated with power state transitions. The bits for PowerStepUp and PowerStepDown are encoded as follows:</p> <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>0000b</td><td>Reserved.</td><td>1000b</td><td>50 ns</td></tr><tr><td>0001b</td><td>Reserved.</td><td>1001b</td><td>Reserved.</td></tr><tr><td>0010b</td><td>Reserved.</td><td>1010b</td><td>Reserved.</td></tr><tr><td>0011b</td><td>100 ns</td><td>1011b</td><td>Reserved.</td></tr><tr><td>0100b</td><td>90 ns</td><td>1100b</td><td>Reserved.</td></tr><tr><td>0101b</td><td>80 ns</td><td>1101b</td><td>Reserved.</td></tr><tr><td>0110b</td><td>70 ns</td><td>1110b</td><td>Reserved.</td></tr><tr><td>0111b</td><td>60 ns</td><td>1111b</td><td>Reserved.</td></tr></table> <ul style="list-style-type: none">• If PowerStepDown or PowerStepUp are programmed to greater than 50 ns, then the value applied to the NB is clipped to 50 ns. The compute unit steps are not clipped.• BIOS: 1000b.	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	0000b	Reserved.	1000b	50 ns	0001b	Reserved.	1001b	Reserved.	0010b	Reserved.	1010b	Reserved.	0011b	100 ns	1011b	Reserved.	0100b	90 ns	1100b	Reserved.	0101b	80 ns	1101b	Reserved.	0110b	70 ns	1110b	Reserved.	0111b	60 ns	1111b	Reserved.
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																																		
0000b	Reserved.	1000b	50 ns																																		
0001b	Reserved.	1001b	Reserved.																																		
0010b	Reserved.	1010b	Reserved.																																		
0011b	100 ns	1011b	Reserved.																																		
0100b	90 ns	1100b	Reserved.																																		
0101b	80 ns	1101b	Reserved.																																		
0110b	70 ns	1110b	Reserved.																																		
0111b	60 ns	1111b	Reserved.																																		
23:20	<p>PowerStepDown. Read-write. Cold reset: 0000b. BIOS: 1000b. This specifies the rate at which blocks of compute unit and NB logic are gated off while the processor transitions from an active state to a quiescent state as part of a power management state transition. Valid values are the same as those for PowerStepUp.</p>																																				
19:18	Reserved.																																				
17:15	Reserved.																																				

14	CacheFlushImmOnAllHalt: cache flush immediate on all halt. Read-write. Cold reset: 0. 1=Flush the caches immediately when all cores in a package have halted. The following condition must be true in order for the caches to be flushed: <ul style="list-style-type: none"> • D18F4x118/D18F4x11C[CacheFlushEn]=1 for the corresponding C-state action field on all cores.
13	Reserved.
12	ClkRampHystCtl: clock ramp hysteresis control. Read-write. Cold reset: 0. Specifies the time base for ClkRampHystSel when (D18F4x128 [CoreCstateMode] ? (D18F3x80/D18F3x84 [CpuPrbEn]==0) : (D18F4x118/D18F4x11C [CpuPrbEn]==0)). 0=320 ns. 1=1.28 us.
11:8	ClkRampHystSel: clock ramp hysteresis select. Read-write. Cold reset: 0h. BIOS: Fh. When the core(s) are in the stop-grant or halt state and a probe request is received, the core clock may need to be brought up to service the probe. <ul style="list-style-type: none"> • If (D18F4x128[CoreCstateMode] ? (D18F3x80/D18F3x84[CpuPrbEn]==0) : (D18F4x118/D18F4x11C[CpuPrbEn]==0)) then this field specifies how long the core clock is left up to service additional probes before being brought back down. Each time a probe request is received, the hysteresis timer is reset such that the period of time specified by this field must expire with no probe request before the core clock is brought back down. The hysteresis time is encoded as (the time base specified by D18F3xD4[ClkRampHystCtl]) * (1 + ClkRampHystSel). • If (D18F4x128[CoreCstateMode] ? (D18F3x80/D18F3x84[CpuPrbEn]==1) : (D18F4x118/D18F4x11C[CpuPrbEn]==1)) then this field specifies a fixed amount of time to allow for probes to be serviced after completing the transition of each core. If, for example, two cores enter stop-grant or halt at the same time, then (1) the first core would complete the transition to the low power state, (2) probe traffic would be serviced for the time specified by this field, (3) the second core would complete the transition to the low power state, and (4) probe traffic would be serviced for the time specified by this field (and afterwards, until the next power state transition). For this purpose, values range from 0h=40 ns to Fh=640 ns, encoded as 40 ns * (1 + ClkRampHystSel).
7:6	Reserved.
5:0	MaxSwPstateCpuCof: maximum software P-state core COF. Read-only. Cold reset: Product-specific. Specifies the maximum CPU COF supported by the processor in a software P-state. The maximum frequency is 100 MHz * MaxSwPstateCpuCof, if MaxSwPstateCpuCof is greater than zero; if MaxSwPstateCpuCof = 00h, then there is no frequency limit. Any attempt to change a software P-state CPU COF to a frequency greater than specified by this field is ignored. See 2.5.3.1.1.1 [Software P-state Numbering] .

D18F3xD8 Clock Power/Timing Control 1

See [2.5.1.4 \[Voltage Transitions\]](#).

Bits	Description
31:7	Reserved.

6:4	VS RampSlamTime. Read-write. Cold reset: 000b. BIOS: 100b. Specifies the time the processor waits for voltage transitions to complete before beginning an additional voltage change or a frequency change. Wait time = (VS RampSlamTime / 15mV) * ABS(destination voltage - current voltage).			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	000b	5.00 us	100b	2.00 us
	001b	3.75 us	101b	1.50 us
	010b	3.00 us	110b	1.20 us
	011b	2.40 us	111b	1.00 us
3:0	Reserved.			

D18F3xDC Clock Power/Timing Control 2

Bits	Description																		
31:30	NbsynPtrAdjPstate[2:1]: NB/core synchronization FIFO pointer adjust P-state[2:1]. Read-write. Reset: Product-specific. See NbsynPtrAdj.																		
29:27	NbsynPtrAdjLo: NB/core synchronization FIFO pointer adjust low. Read-write. Cold reset: 000b. BIOS: 101b. See NbsynPtrAdj.																		
26	IgnCpuPrbEn: ignore CPU probe enable. Read-write. Cold reset: 0. BIOS: 0. See D18F3x80/D18F3x84[CpuPrbEn] and D18F4x118/D18F4x11C[CpuPrbEn] .																		
25:19	CacheFlushOnHaltTmr: cache flush on halt timer. Read-write. Cold reset: 00h. IF (BatteryPower) THEN BIOS: 4h. ELSE BIOS: Fh. ENDIF. Specifies how long each core needs to stay in a C-state before it flushes its caches. See CacheFlushOnHaltCtl, D18F3x80/D18F3x84[CpuPrbEn] , and D18F4x118/D18F4x11C[CacheFlushTmrSel] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>5.12 us</td></tr> <tr> <td>7Fh-01h</td><td>(<CacheFlushOnHaltTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushOnHaltTmr> * 10.24 us</td></tr> </table>	Bits	Description	00h	5.12 us	7Fh-01h	(<CacheFlushOnHaltTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushOnHaltTmr> * 10.24 us												
Bits	Description																		
00h	5.12 us																		
7Fh-01h	(<CacheFlushOnHaltTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushOnHaltTmr> * 10.24 us																		
18:16	CacheFlushOnHaltCtl: cache flush on halt control. Read-write. Cold reset: 000b. BIOS: 000b. Enables cache flush on halt when (CacheFlushOnHaltCtl != 0). Specifies what core clock divisor is used after the caches have been flushed. See D18F4x118/D18F4x11C[CacheFlushTmrSel] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Divide-by 1.</td></tr> <tr> <td>001b</td><td>Divide-by 2</td></tr> <tr> <td>010b</td><td>Divide-by 4</td></tr> <tr> <td>011b</td><td>Divide-by 8</td></tr> <tr> <td>100b</td><td>Divide-by 16</td></tr> <tr> <td>101b</td><td>Reserved</td></tr> <tr> <td>110b</td><td>Reserved</td></tr> <tr> <td>111b</td><td>Turn off clocks</td></tr> </table> See D18F3x[84:80] and D18F4x11[C:8] for clock divisor specifications that are in effect during a C-state before the caches have been flushed. See 2.5.3.2.3.1 [C-state Probes and Cache Flushing] .	Bits	Description	000b	Divide-by 1.	001b	Divide-by 2	010b	Divide-by 4	011b	Divide-by 8	100b	Divide-by 16	101b	Reserved	110b	Reserved	111b	Turn off clocks
Bits	Description																		
000b	Divide-by 1.																		
001b	Divide-by 2																		
010b	Divide-by 4																		
011b	Divide-by 8																		
100b	Divide-by 16																		
101b	Reserved																		
110b	Reserved																		
111b	Turn off clocks																		

15	NbsynPtrAdjPstate[0]: NB/core synchronization FIFO pointer adjust P-state[0]. Read-write. Reset: Product-specific. See NbsynPtrAdj.						
14:12	<p>NbsynPtrAdj: NB/core synchronization FIFO pointer adjust. Read-write. Cold reset: 000b. BIOS: 110b.</p> <p>Changes to this field take effect after any of the following events:</p> <ul style="list-style-type: none"> • Warm reset. • At least one core on all compute units perform a P-state transition. • An NB P-state transition. <p>There is a synchronization FIFO between the NB clock domain and core clock domains. At cold reset, the read pointer and write pointer for each of these FIFOs is positioned conservatively, such that FIFO latency may be greater than is necessary.</p> <p>NbsynPtrAdj and NbsynPtrAdjLo may be used to position the read pointer and write pointer of each FIFO closer to each other such that latency is reduced. Each increment of NbsynPtrAdj and NbsynPtrAdjLo represents one clock cycle of whichever is the slower clock (longer period) between the NB clock and the core clock. NbsynPtrAdj is used when the core P-state is less than or equal to NbsynPtrAdjPstate, otherwise NbsynPtrAdjLo is used.</p> <p>Values less than the recommended value are allowed; values greater than the recommended value are illegal.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>6h-0h</td><td>Position the read pointer <NbsynPtrAdj, NbsynPtrAdjLo> clock cycles closer to the write pointer.</td></tr> <tr> <td>7h</td><td>Reserved</td></tr> </table>	Bits	Description	6h-0h	Position the read pointer <NbsynPtrAdj, NbsynPtrAdjLo> clock cycles closer to the write pointer.	7h	Reserved
Bits	Description						
6h-0h	Position the read pointer <NbsynPtrAdj, NbsynPtrAdjLo> clock cycles closer to the write pointer.						
7h	Reserved						
11	Reserved.						
10:8	<p>HwPstateMaxVal: P-state maximum value. Read-write. IF ((D18F3xE8[HtcCapable]==1) && (D18F3x64[HtcTmpLmt]!=0) && (D18F3x64[HtcPstateLimit] > HwPstateMaxVal)) THEN BIOS: D18F3x64[HtcPstateLimit]. ENDIF. Cold reset: specified by the reset state of MSRC001_00[6B:64][PstateEn]; the cold reset value is the highest P-state number corresponding to the MSR in which PstateEn is set (e.g., if MSRC001_0064 and MSRC001_0065 have this bit set and the others do not, then HwPstateMaxVal=1; if MSRC001_0064 has this bit set and the others do not, then HwPstateMaxVal=0). This specifies the highest P-state value (lowest performance state) supported by the hardware. This field must not be written to a value less (higher performance) than MSRC001_0071[CurPstateLimit].</p> <p>See MSRC001_0061[PstateMaxVal]. This field uses hardware P-state numbering. See 2.5.3.1.1.2 [Hardware P-state Numbering].</p>						
7:0	Reserved.						

D18F3xE4 Thermtrip Status

Bits	Description
31	SwThermtp: software THERMTRIP. Write-1-only; cleared-by-hardware. Reset: 0. Writing a 1 to this bit position induces a THERMTRIP event. This bit returns 0 when read. This is a diagnostic bit, and it should be used for testing purposes only.
30:6	Reserved.

5	ThermtpEn: THERMTRIP enable. Read-only. Reset: Product-specific. 1=The THERMTRIP state is supported. See 2.10.3.3 [THERMTRIP] .
4	Reserved.
3	ThermtpSense: THERMTRIP sense. Read-only. Cold reset: 0. 1=The processor temperature exceeded the THERMTRIP value (regardless as to whether the THERMTRIP state is enabled). This bit is also set when the diagnostic bit SwThermtp = 1.
2	Reserved.
1	Thermtp: THERMTRIP. Read-only. Cold reset: 0. 1=The processor has entered the THERMTRIP state.
0	Reserved.

D18F3xE8 Northbridge Capabilities

Read-only. Value: Product-specific. Unless otherwise specified, 1=The feature is supported by the processor; 0=The feature is not supported.

Bits	Description
31:29	Reserved.
28	SUCCOR. Read-only. See CPUID Fn8000_0007_EBX[SUCCOR] . Value: 0.
27:26	Reserved.
25	Reserved.
24	MemPstateCap: memory P-state capable.
23:20	Reserved.
19	x2Apic: x2APIC capability. Value: 0.
18:16	Reserved.
15	Reserved.
14	MultVidPlane: multiple VID plane capable. Value: 1.
13:12	Reserved.
11	Reserved.
10	HtcCapable: HTC capable. This affects D18F3x64 and D18F3x68 .
9	SvmCapable: SVM capable.
8	MctCap: memory controller (on the processor) capable. Value: 1.
7:5	Reserved.
4	ChipKill: chipkill ECC capable.
3	ECC: ECC capable.
2	EightNode: Eight-node multi-processor capable.

1	DualNode: Dual-node multi-processor capable.
0	Reserved.

D18F3xF0 DEV Capability Header Register

The DEV secure loader function is configured through [D18F3xF4](#) and [D18F3xF8](#). The register number (i.e., the number that follows F8_x in the register mnemonic) is specified by [D18F3xF4\[DevFunction\]](#). Access to this register is accomplished as follows:

- Reads: Write the register number to [D18F3xF4\[DevFunction\]](#). Read the register contents from [D18F3xF8](#).
- Writes: Write the register number to [D18F3xF4\[DevFunction\]](#). Write the register contents to [D18F3xF8](#).

IF ([D18F3xE8\[SvmCapable\]](#)==0) THEN

Bits	Description
31:0	Reserved.

ELSE

Bits	Description
31:0	Reserved.

ENDIF.

D18F3xF4 DEV Function Register

Reset: 0000_0000h. Reserved if ([D18F3xE8\[SvmCapable\]](#)==0).

Bits	Description
31:0	Reserved.

D18F3xF8 DEV Data Port

Reset: 0000_0000h. Address: [D18F3xF4\[DevFunction\]](#). See [D18F3xF0](#) for details about this port.

Bits	Description
31:0	Reserved.

D18F3xF8_x4 DEV Secure Loader Control Register

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:5	Reserved.
4:0	Reserved.

D18F3xFC CUID Family/Model/Stepping

[CUID Fn0000_0001_EAX](#), [CUID Fn8000_0001_EAX](#) are an alias of [D18F3xFC](#).

Bits	Description
31:28	Reserved.
27:20	ExtFamily: extended family. Read-only. Value: 07h.
19:16	ExtModel: extended model. Read-only. Value: Product-specific.
15:12	Reserved.
11:8	BaseFamily. Read-only. Reset: Fh.
7:4	BaseModel. Read-only. Value: Product-specific.
3:0	Stepping. Read-only. Value: Product-specific.

D18F3x138 DCT0 Bad Symbol Identification

Bits	Description
31:0	Reserved.

D18F3x13C DCT1 Bad Symbol Identification

Bits	Description
31:0	Reserved.

D18F3x140 SRI to XCS Token Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C](#)[RIsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

[D18F3x140](#), [D18F3x144](#), and [D18F3x1\[54:48\]](#) specify the number of XCS (XBAR command scheduler) entries assigned to each virtual channel within each source port. See [2.8 \[Northbridge \(NB\)\]](#).
The default totals are:

Buffer allocation rules:

- The totals of SRI, MCT and the links must not exceed the number of XCS entries. XcsSize = 44.
 - $\text{SUM}(\text{D18F3x140}[\text{UpReqTok}, \text{UpPreqTok}, \text{UpRspTok}, \text{DnReqTok}, \text{DnPreqTok}, \text{DnRspTok}, \text{IsocReqTok}, \text{IsocPreqTok}, \text{IsocRspTok}, \text{FreeTok}]) + \text{SUM}(\text{D18F3x144}[\text{ProbeTok}, \text{RspTok}]) + \text{SUM}(\text{D18F3x148}[\text{ReqTok0}, \text{PReqTok0}, \text{RspTok0}, \text{ProbeTok0}, \{\text{FreeTok}[3:2], \text{FreeTok}[1:0]\}, \text{IsocReqTok0}, \text{IsocPReqTok0}, \text{IsocRspTok0}, \text{ReqTok1}, \text{PReqTok1}, \text{RspTok1}, \text{ProbeTok1}, \text{IsocReqTok1}, \text{IsocPReqTok1}, \text{IsocRspTok1}]) + \text{SUM}(\text{D18F3x14C}[\text{ReqTok0}, \text{PReqTok0}, \text{RspTok0}, \text{ProbeTok0}, \{\text{FreeTok}[3:2], \text{FreeTok}[1:0]\}, \text{IsocReqTok0}, \text{IsocPReqTok0}, \text{IsocRspTok0}, \text{ReqTok1}, \text{PReqTok1}, \text{RspTok1}, \text{ProbeTok1}, \text{IsocReqTok1}, \text{IsocPReqTok1}, \text{IsocRspTok1}]) \leq \text{XcsSize}$. See [D18F3x1\[54:48\]](#).

The defaults for [D18F3x140](#) and [D18F3x1\[54:48\]](#) do not allocate any tokens in the isochronous channel. If isochronous flow control mode (IFCM) is enabled ([D18F0x\[E4,C4,A4,84\]](#)[IsocEn]), then the XCS token counts must be changed.

- If IFCM is enabled, then [D18F3x140](#)[IsocReqTok, IsocRspTok] must each be non-zero. If isochronous posted requests may be generated in the system, then [D18F3x140](#)[IsocPreqTok] must also be non-zero.
- If an IOMMU is present, [D18F3x1\[54:48\]](#)[IsocReqTok] must be non-zero.

Bits	Description
31:25	Reserved.
24:20	FreeTok: free tokens. Read-write. Cold Reset: 0Ch. BIOS: Fh. The number of free tokens must always be greater than or equal to 2 to ensure deadlock free operation.
19:18	Reserved.
17:16	IsocRspTok: isochronous response tokens. Read-write. Cold Reset: 0. BIOS: 1.
15:14	IsocPreqTok: isochronous posted request tokens. Read-write. Cold Reset: 0. BIOS: 0.
13:12	IsocReqTok: isochronous request tokens. Read-write. Cold Reset: 0. BIOS: 1.
11:10	DnRspTok: downstream response tokens. Read-write. Cold Reset: 1. BIOS: 1.
9:8	UpRspTok: upstream response tokens. Read-write. Cold Reset: 3. BIOS: 1.
7:6	DnPreqTok: downstream posted request tokens. Read-write. Cold Reset: 1. BIOS: 1.
5:4	UpPreqTok: upstream posted request tokens. Read-write. Cold Reset: 1. BIOS: 2.
3:2	DnReqTok: downstream request tokens. Read-write. Cold Reset: 1. BIOS: 1.
1:0	UpReqTok: upstream request tokens. Read-write. Cold Reset: 3. BIOS: 2.

D18F3x144 MCT to XCS Token Count

See [D18F3x140](#).

Bits	Description
31:8	Reserved.
7:4	ProbeTok: probe tokens. Read-write. Cold Reset: 7h. BIOS: 4h.
3:0	RspTok: response tokens. Read-write. Cold Reset: 7h. BIOS: 7h.

D18F3x1[54:48] Link to XCS Token Count

See [D18F3x140](#).

Table 186: [Register Mapping](#) for [D18F3x1\[54:48\]](#)

Register	Function
D18F3x148	ONION Link
D18F3x1[54:4C]	Reserved

Bits	Description
31:30	FreeTok[3:2]: free tokens. Read-write. Cold reset: 00b. BIOS: 0. See FreeTok[1:0].
29	Reserved.
28	IsocRspTok1: isochronous response tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
27	Reserved.
26	IsocPreqTok1: isochronous posted request tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
25	Reserved.
24	IsocReqTok1: isochronous request tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
23:22	ProbeTok1: probe tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
21:20	RspTok1: response tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
19:18	PRReqTok1: posted request tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
17:16	ReqTok1: request tokens sublink 1. Read-write. Cold reset: 0. BIOS: 0.
15:14	FreeTok[1:0]: free tokens. Read-write. Cold reset: 00b. FreeTok[3:0] = {FreeTok[3:2], FreeTok[1:0]}. BIOS: 00b.
13:12	IsocRspTok0: isochronous response tokens sublink 0. Read-write. Cold reset: 0. BIOS: 0.
11:10	IsocPreqTok0: isochronous posted request tokens sublink 0. Read-write. Cold reset: 0. BIOS: IF (REG==D18F3x148) THEN 1 ELSE 0 ENDIF. See D18F0x6C [ApplyIsocModeEnNow].

9:8	IsocReqTok0: isochronous request tokens sublink 0. Read-write. Cold reset: 0. BIOS: IF (REG==D18F3x148) THEN 1 ELSE 0 ENDIF.
7:6	ProbeTok0: probe tokens sublink 0. Read-write. Cold reset: 2. BIOS: 0.
5:4	RspTok0: response tokens sublink 0. Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 0 ENDIF.
3:2	PReqTok0: posted request tokens sublink 0. Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 0 ENDIF.
1:0	ReqTok0: request tokens sublink 0. Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 3 ENDIF.

D18F3x160 NB Machine Check Misc (DRAM Thresholding) 0 (MC4_MISC0)

See 2.16.1 [Machine Check Architecture] for a general description of the machine check architecture.

See 2.16.1.7 [Error Thresholding]. D18F3x160 is associated with the DRAM error type. See MSR0000_0413.

Bits	Description
31	Valid. Read-only. Reset: 1.
30	CntP: counter present. Read-only. Reset: 1.
29	Locked. Read-only. Reset: 0.
28:24	Reserved.
23:20	LvtOffset: LVT offset. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0h. BIOS: 1h.
19	CntEn: counter enable. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
18:17	IntType: interrupt type. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0.
16	Ovrflw: overflow. IF (Locked) THEN Read-only; set-by-hardware. ELSE Read-write; set-by-hardware. ENDIF. Cold reset: 0.
15:12	Reserved.
11:0	ErrCnt: error counter. IF (Locked) THEN Read-only; updated-by-hardware. ELSE Read-write; updated-by-hardware. ENDIF. Cold reset: 0.

D18F3x168 NB Machine Check Misc (Link Thresholding) 1 (MC4_MISC1)

See 2.16.1.7 [Error Thresholding]. D18F3x168 is associated with the link error type. See MSRC000_0408.

Bits	Description
31	Valid. Read-only. Reset: 1.
30	CntP: counter present. Read-only. Reset: 1.
29	Locked. Read-only. Reset: 0.
28:24	Reserved.
23:20	LvtOffset: LVT offset. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0h. BIOS: 1h.

19	CntEn: counter enable. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
18:17	IntType: interrupt type. IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0.
16	Ovrflw: overflow. IF (Locked) THEN Read-only; set-by-hardware. ELSE Read-write; set-by-hardware. ENDIF. Cold reset: 0.
15:12	Reserved.
11:0	ErrCnt: error counter. IF (Locked) THEN Read-only; updated-by-hardware. ELSE Read-write; updated-by-hardware. ENDIF. Cold reset: 0.

D18F3x17C Extended Freelist Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C](#)[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

Bits	Description
31:4	Reserved.
3:0	SPQPrbFreeCBC: XBAR to SRI Probe command buffer freelist. Cold Reset: 8h. Read-write. BIOS: 8h.

D18F3x180 Extended NB MCA Configuration

Reset: 0000_0000h. This register is an extension of [D18F3x44](#) [MCA NB Configuration].

Bits	Description
31	Reserved.
30	Reserved.
29	Reserved.
28	SyncFloodOnCC6DramUcErr. Read-write. BIOS: 1. 1=Enable generation of SyncFlood when we hit an Uncorrectable ECC error on C6 restore reads.
27	Reserved.
26	ConvertUnCorToCorErrEn: convert uncorrectable error to correctable error enable. Read-write. 1=The status of uncorrectable errors is changed to appear as correctable errors; MSR0000_0411 [UC, PCC] are cleared and a machine check exception will not be raised. For uncorrectable ECC errors, MSR0000_0411 [UECC] is cleared and MSR0000_0411 [CECC] is set. This field is intended for debug observability.
25	EccSymbolSize: ECC symbol size and code selection. Read-write. BIOS: See 2.16.2 [DRAM ECC Considerations]. 0=x4 symbol size and code used.1=reserved

24	McaLogErrAddrWdtErr: log error address on WDT errors. Read-write. BIOS: 1. 1=When a watchdog timeout error occurs (see MSR0000_0410 [WDT RptEn]), the associated address is logged and MSR0000_0411 [AddrV] is set. 0=When a watchdog timeout error occurs, NB state information is saved and MSR0000_0411 [AddrV] is cleared. See D18F3x50 for details on saved information.
23	SyncFloodOnDramTempErr. Read-write. 1=SyncFlood is generated on a DRAM temp Error.
22	Reserved.
21	SyncFloodOnCpuLeakErr: sync flood on CPU leak error. Read-write. BIOS: 1. 1=Enable sync flood when one of the cores encounters an uncorrectable error which cannot be contained to the process on the core.
20	Reserved.
19	PwP2pDatErrRmtPropDis: posted write for remote peer-to-peer data error propagation disable. Read-write. 1= A peer-to-peer posted write with a data error is not propagated to the target IO link chain if the target IO link chain is not attached to the local node (the same node as the source IO link chain). Instead, the write is dropped by the host bridge. The state of this field is ignored if SyncFloodOnUsPwDatErr==1 or DatWrErrDeferEn==0.
18	PwP2pDatErrLclPropDis: posted write for local peer-to-peer data error propagation disable. Read-write. 1=A peer-to-peer posted write with a data error is not propagated to the target IO link chain if the target IO link chain is attached to the local node (the same node as the source IO link chain). Instead, the write is dropped by the host bridge. The state of this field is ignored if SyncFloodOnUsPwDatErr==1 or DatWrErrDeferEn==0.
17	SyncFloodOnDeferErrToIO: convert deferred error for an IO link to sync flood enable. Read-write. BIOS: 1. 1=A deferred error which targets an IO link device is turned into a sync flood. <ul style="list-style-type: none"> When DramErrDeferEn is set and the read response is for a DMA read with a data error, setting SyncFloodOnDeferErrToIO causes a sync flood. When DatWrErrDeferEn is set and the write is peer-to-peer, setting SyncFloodOnDeferErrToIO causes a sync flood.
16	DeferDatErrNcHtMcaEn: convert deferred error for an IO link to machine check exception enable. IF (D18F3xE8 [SUCCOR]) THEN Read-write. ELSE Read-only. ENDIF. 1=A deferred error which targets an IO link device is turned into a machine check exception. <ul style="list-style-type: none"> When DramErrDeferEn is set and the read response is for a DMA read with a data error, setting DeferDatErrNcHtMcaEn causes an uncorrected error to be logged and a machine check exception to be generated. An error response is returned to the IO device irrespective of the setting of DeferDatErrNcHtMcaEn. When DatWrErrDeferEn is set and the write is peer-to-peer, setting DeferDatErrNcHtMcaEn causes an uncorrected error to be logged and a machine check exception to be generated. An error indication is sent to the target IO device irrespective of the setting of DeferDatErrNcHtMcaEn.
15	Reserved.
14:11	Reserved.
10	Reserved.
9	SyncFloodOnUCNbAry: sync flood on UC NB array error. Read-write. BIOS: 1. 1=Enable sync flood on detection of an UC error in an NB array.

8	SyncFloodOnProtErr: sync flood on protocol error. Read-write. BIOS: 1. 1=Enable sync flood on detection of link protocol error, L3 protocol error, and probe filter protocol error.
7	SyncFloodOnTgtAbortErr. Read-write. BIOS: 1. 1=Enable sync flood on generated or received link responses that indicate target aborts.
6	SyncFloodOnDatErr. Read-write. BIOS: 1. 1=Enable sync flood on generated or received link responses that indicate data error.
5	DisPciCfgCpuMstAbortRsp. Read-write. BIOS: 1. 1=For master abort responses to CPU-initiated configuration accesses, disables MCA error reporting and generation of an error response to the core. It is recommended that this bit be set in order to avoid MCA exceptions being generated from master aborts for PCI configuration accesses, which are common during device enumeration.
4	ChgMstAbortToNoErr. Read-write. 1=Signal no errors instead of master abort in link response packets to IO devices on detection of a master abort condition. When ChgMstAbortToNoErr and D18F3x44 [IoMstAbortDis] are both set, ChgMstAbortToNoErr takes precedence.
3	ChgDatErrToTgtAbort. Read-write. 1=Signal target abort instead of data error in link response packets to IO devices (for Gen1 link compatibility).
2	WDTCntSel[3]: watchdog timer count select bit[3]. Read-write. See D18F3x44 [WDTCntSel].
1	SyncFloodOnUsPwDatErr: sync flood on upstream posted write data error. Read-write. BIOS: 1. 1=Enable sync flood generation when an upstream posted write data error is detected.
0	McaLogUsPwDatErrEn: MCA log of upstream posted write data error enable. Read-write. BIOS: 1. 1=Enable logging of upstream posted write data errors in MCA (if NB MCA registers are appropriately enabled and configured).

D18F3x188 NB Configuration 2

Same-for-all.

Bits	Description
31:28	Reserved.
27	DisCpuWrSzDw64ReOrd: disable streaming store reorder. Read-write. Reset: 1. BIOS: 1. 1=Disable reordering of streaming store commands.
26:10	Reserved.
9	DisL3HiPriFreeListAlloc. Read-write. Reset: 0. BIOS: 1. 1=Disables normal SRQ entry scheme which gives higher priority to XBAR.
8:0	Reserved.

D18F3x190 Downcore Control

Cold reset: 0000_0000h. See [2.4.4 \[Processor Cores and Downcoring\]](#) and [2.4.4.1 \[Software Downcoring using D18F3x190\[DisCore\]\]](#).

Bits	Description										
31:0	DisCore. Read-write; reset-applied. 0=Core enabled. 1=Core disabled. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Core 0.</td></tr> <tr> <td>[2:1]</td><td>Core <BIT>.</td></tr> <tr> <td>[3]</td><td>Core 3.</td></tr> <tr> <td>[31:4]</td><td>Reserved.</td></tr> </table>	Bit	Description	[0]	Core 0.	[2:1]	Core <BIT>.	[3]	Core 3.	[31:4]	Reserved.
Bit	Description										
[0]	Core 0.										
[2:1]	Core <BIT>.										
[3]	Core 3.										
[31:4]	Reserved.										

D18F3x1A0 Core Interface Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use **D18F0x6C**[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- The following buffer allocations rules must be satisfied:
 - CpuCmdBufCnt >= 2.

Bits	Description								
31	Reserved.								
30:26	NbToCpuPrbLmt. Read-write. Reset: 10h. Maximum number of outstanding probes to the compute-unit. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>02h-00h</td><td>Reserved</td></tr> <tr> <td>0Fh-03h</td><td>Maximum of <NbToCpuPrbLmt> probes.</td></tr> <tr> <td>1Fh-10h</td><td>Reserved</td></tr> </table>	Bits	Description	02h-00h	Reserved	0Fh-03h	Maximum of <NbToCpuPrbLmt> probes.	1Fh-10h	Reserved
Bits	Description								
02h-00h	Reserved								
0Fh-03h	Maximum of <NbToCpuPrbLmt> probes.								
1Fh-10h	Reserved								
25:24	Reserved.								
23:20	NbToCpuDatReqLmt. Read-write. Reset: Ch. Octword outstanding per core limit. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>Ch-0h</td><td>Octword outstanding per core limit</td></tr> <tr> <td>Fh-Dh</td><td>Reserved</td></tr> </table>	Bits	Description	Ch-0h	Octword outstanding per core limit	Fh-Dh	Reserved		
Bits	Description								
Ch-0h	Octword outstanding per core limit								
Fh-Dh	Reserved								
19	Reserved.								
18:16	CpuToNbFreeBufCnt. Read-write. Cold Reset: 2h. BIOS: 011b. Provides the number of tokens which can be released to each compute unit from the freelist pool. This field can be updated at any time by BIOS and does not require a warm reset to take effect. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>Number of tokens released to each compute unit from the freelist pool.</td></tr> <tr> <td>7h-4h</td><td>Reserved</td></tr> </table>	Bits	Description	3h-0h	Number of tokens released to each compute unit from the freelist pool.	7h-4h	Reserved		
Bits	Description								
3h-0h	Number of tokens released to each compute unit from the freelist pool.								
7h-4h	Reserved								
15:12	Reserved. Cold reset: 4h.								
11:10	Reserved.								
9:4	Reserved. Cold reset: Product-specific.								

3	Reserved.
2:0	CpuCmdBufCnt: CPU to SRI command buffer count. Read-write; reset-applied. Cold Reset: 2h. BIOS: 1h. Each compute unit is allocated the number of buffers specified by this field.

D18F3x1CC IBS Control

Reset: 0000_0000h. [MSRC001_103A](#) is an alias of [D18F3x1CC](#). [D18F3x1CC](#) is programmed by BIOS; The OS reads the LVT offset from [MSRC001_103A](#).

Bits	Description						
31:9	Reserved.						
8	LvtOffsetVal: local vector table offset valid. Read-write. BIOS: 1. 1=The offset in LvtOffset is valid. 0=The offset in LvtOffset is not valid and IBS interrupt generation is disabled.						
7:4	Reserved.						
3:0	LvtOffset: local vector table offset. Read-write. BIOS: 0h. Specifies the address of the IBS LVT entry in the APIC registers. See APIC[530:500] . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>LVT address = <500h + LvtOffset<<4></td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Description	3h-0h	LVT address = <500h + LvtOffset<<4>	Fh-4h	Reserved
Bits	Description						
3h-0h	LVT address = <500h + LvtOffset<<4>						
Fh-4h	Reserved						

D18F3x1FC Product Information Register 1

Bits	Description
31:14	Reserved.
13	StapmCapable. Value: Product-specific.
12:5	DiDtCfg. Value: Product-specific. FP power management policy.
4:1	USB2CompCal[3:0]. Value: Product-specific. Specifies USB2.0 common PHY calibration bus value.
0	DcTdpSupport. Value: Product-specific. 1=Dynamic Configurable TDP supported.

D18F3x200 Performance Mode Control Register

Bits	Description
31:8	Reserved.
7:4	EnCpuSkidBufFull. Read-write. Reset: 0. Enables optimal use of the CPU skid buffers, in the presence of multiple data movement requests from the same core.
3	EnMcqPrbPickThrottle. Read-write. Reset: 0. BIOS: 0. 1=Enabling throttling the MCQ to ensure the bypass path is taken by the probes instead of allocating in to the XCS.
2	EnDctOddToNcLnkDatXfr. Read-write. Reset: 0. BIOS: 0. 1=Enables direct transfer of data from odd-numbered DRAM channels (1,3,..) to non-coherent links on the local node.

1	EnDctEvnToNcLnkDatXfr. Read-write. Reset: 0. BIOS: 0. 1=Enables direct transfer of data from even-numbered DRAM channels (0,2,...) to non-coherent links on the local node.
0	Reserved.

D18F3x238 DCT2 Bad Symbol Identification

Bits	Description
31:0	Reserved.

D18F3x23C DCT3 Bad Symbol Identification

Bits	Description
31:0	Reserved.

D18F3x2B4 DCT and Fuse Power Gate Control

Bits	Description
31:27	Reserved.
26:12	Reserved.
11:0	Reserved.

3.13 Device 18h Function 4 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F4x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1584h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F4x04 Status/Command

Bits	Description
31:16	Status. Read-only. Reset: 0000_0000_000X_0000b. Only Status[4] may be set to indicate the existence of a PCI-defined capability block. 0=No supported links are ungang. 1=At least one link may be ungang, in which case there is a capability block associated with sublink one of the link in this function.
15:0	Command. Read-only. Value: 0000h.

D18F4x08 Class Code/Revision ID

Reset: 0600_0000h.

Bits	Description
31:8	ClassCode. Read-only. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only.

D18F4x0C Header Type

Reset: 0080_0000h.

Bits	Description
31:0	HeaderTypeReg. Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device.

D18F4x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Value: 00h.

D18F4x110 Sample and Residency Timers

Bits	Description
31:21	Reserved.
20:13	MinResTmr: minimum residency timer. IF D18F4x15C [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Cold reset: Product-specific. Specifies the minimum amount of time required between TDP-initiated P-state transitions. The minimum amount of time is defined as MinResTmr * CSampleTimer * 5.12us .
12	Reserved.
11:0	CSampleTimer. Read-write. Cold reset: 0. BIOS: 14h. Specifies the value that the internal CSampleTimer counter must increment to before expiring. When the internal CSampleTimer counter expires, it is reset to 0. See 2.5.9 [Application Power Management (APM)] .

D18F4x11[C:8] C-state Control

[D18F4x11\[C:8\]](#) consist of three identical 16-bit registers, one for each C-state Action Field (CAF) associated with an IO address that is read to enter C-states. Refer to [2.5.3.2 \[Core C-states\]](#).

- [D18F4x118](#)[15:0] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001_0073](#)[CstateAddr].
- [D18F4x118](#)[31:16] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001_0073](#)[CstateAddr]+1.
- [D18F4x11C](#)[15:0] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001_0073](#)[CstateAddr]+2.

D18F4x118 C-state Control 1

Bits	Description
31:30	Reserved.
29	SelfRefrEarly1. Read-write. Reset: 0. See: SelfRefrEarly0. BIOS: 0.
28	SelfRefr1. Read-write. Reset: 0. See: SelfRefr0. BIOS: 1.
27	NbClkGate1. Read-write. Reset: 0. See: NbClkGate0. BIOS: 1.
26	NbPwrGate1. Read-write. Reset: 0. See: NbPwrGate0. BIOS: 1.
25	PwrOffEnCstAct1. Read-write; updated-by-SMU. Reset: 0. See: PwrOffEnCstAct0. BIOS: 1.
24	PwrGateEnCstAct1. Read-write. Reset: 0. See: PwrGateEnCstAct0. BIOS: 1.

23:21	ClkDivisorCstAct1 . Read-write. Reset: 0. See: ClkDivisorCstAct0. BIOS: 000b.
20	Reserved.
19:18	CacheFlushTmrSelCstAct1 . Read-write. Reset: 0. See: CacheFlushTmrSelCstAct0. BIOS: 10b.
17	CacheFlushEnCstAct1 . Read-write. Reset: 0. See: CacheFlushEnCstAct0. BIOS: 1.
16	CpuPrbEnCstAct1 . Read-write. Reset: 0. See: CpuPrbEnCstAct0. BIOS: 1.
15:14	Reserved.
13	SelfRefrEarly0: allow early self-refresh . Read-write. Reset: 0. BIOS: 0. 1=Allow self-refresh while cores in PC1 or CC1 are waiting for the cache flush timer to expire. 0=Wait for cache flush timer to expire before allowing self-refresh. See 2.5.7.2 [DRAM Self-Refresh] and 2.5.3.2.3.1 [C-state Probes and Cache Flushing] .
12	SelfRefr0: self-refresh . Read-write. Reset: 0. BIOS: 1. 1=Allow DRAM self-refresh while in NB C-states. 0=Prevent DRAM self-refresh while in NB C-states. NbClkGate0 must be equal to SelfRefr0. See 2.5.7.2 [DRAM Self-Refresh] and 2.5.4.2 [NB C-states] .
11	NbClkGate0: NB clock-gating . Read-write. Reset: 0. BIOS: 1. 1=Allow clock-gating of the NB. 0=Prevent clock-gating of the NB. NbClkGate0 must be equal to SelfRefr0. See 2.5.4.2 [NB C-states] .
10	NbPwrGate0: NB power-gating . Read-write. Reset: 0. BIOS: 1. 1=Allow power-gating of the NB. 0=Prevent power-gating of the NB. NbPwrGate0 can only be programmed to 1 if NbClkGate0 and SelfRefr0 are programmed to 1. See 2.5.4.2 [NB C-states] .
9	PwrOffEnCstAct0: power off enable . Read-write; updated-by-SMU. Reset: 0. BIOS: 1. 1=Package power off enable. CacheFlushEnCstAct0 is required to be set if this bit is set. PwrGateEnCstAct0 is required to be set if this bit is set. See 2.5.3.2.3.4 [Package C6 (PC6) State] .
8	PwrGateEnCstAct0: power gate enable . Read-write. Reset: 0. BIOS: 1. 1=Core power gating is enabled. CacheFlushEnCstAct0 is required to be set if this bit is set. See 2.5.3.2.3.3 [Core C6 (CC6) State] .

7:5	<p>ClkDivisorCstAct0: clock divisor. Read-write. Reset: 0. BIOS: 000b.</p> <p>Specifies the core clock frequency while in the low-power state before the caches are flushed. This divisor is relative to the current FID frequency, or:</p> <ul style="list-style-type: none">100 MHz * (10h + MSRC001_00[6B:64][CpuFid]) of the current P-state specified by MSRC001_0063[CurPstate]. <p>If MSRC001_00[6B:64][CpuDid] of the current P-state indicates a divisor that is deeper than specified by this field, then no frequency change is made when entering the low-power state associated with this register.</p> <table><tr><th><u>Bits</u></th><th><u>Description</u></th><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>000b</td><td>/1</td><td>100b</td><td>/16</td></tr><tr><td>001b</td><td>/2</td><td>101b</td><td>/128</td></tr><tr><td>010b</td><td>/4</td><td>110b</td><td>/512</td></tr><tr><td>011b</td><td>/8</td><td>111b</td><td>Turn off clocks.</td></tr></table> <p>See CacheFlushTmrSelCstAct0.</p>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	000b	/1	100b	/16	001b	/2	101b	/128	010b	/4	110b	/512	011b	/8	111b	Turn off clocks.
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																		
000b	/1	100b	/16																		
001b	/2	101b	/128																		
010b	/4	110b	/512																		
011b	/8	111b	Turn off clocks.																		
4	Reserved.																				
3:2	<p>CacheFlushTmrSelCstAct0: cache flush timer select. Read-write. Reset: 0. BIOS: 10b. Specifies the timer to use for cache flush.</p> <table><tr><th><u>Bits</u></th><th><u>Cache flush timer</u></th></tr><tr><td>00b</td><td>0 us</td></tr><tr><td>01b</td><td>D18F3xDC[CacheFlushOnHaltTmr]</td></tr><tr><td>10b</td><td>D18F4x128[CacheFlushTmr]</td></tr><tr><td>11b</td><td>Reserved</td></tr></table> <p>Each core has one timer.</p> <p>D18F3xDC[CacheFlushOnHaltCtl] specifies the core clock divisor to use after the caches are flushed. Writing values greater than 10b result in 10b. See CacheFlushEnCstAct0 and CpuPrbEnCstAct0.</p>	<u>Bits</u>	<u>Cache flush timer</u>	00b	0 us	01b	D18F3xDC[CacheFlushOnHaltTmr]	10b	D18F4x128[CacheFlushTmr]	11b	Reserved										
<u>Bits</u>	<u>Cache flush timer</u>																				
00b	0 us																				
01b	D18F3xDC[CacheFlushOnHaltTmr]																				
10b	D18F4x128[CacheFlushTmr]																				
11b	Reserved																				
1	<p>CacheFlushEnCstAct0: cache flush enable. Read-write. Reset: 0. BIOS: 1. 1=Cache flush enable. The cache flush timer starts counting when the C-state is entered. See CacheFlushTmrSelCstAct0 and 2.5.3.2.3.1 [C-state Probes and Cache Flushing].</p> <p>PwrGateEnCstAct0 is required to be set if this bit is set.</p>																				
0	<p>CpuPrbEnCstAct0: core direct probe enable. Read-write. Reset: 0. BIOS: 1. Specifies how probes are handled while in the low-power state. 0=When the probe request comes into the NB, the core clock is brought up to the COF (based on the current P-state), all outstanding probes are completed, the core waits for a hysteresis time based on D18F3xD4[ClkRampHystSel], and then the core clock is brought down to the frequency specified by ClkDivisorCstAct0. 1=The core clock does not change frequency; the probe is handled at the frequency specified by ClkDivisorCstAct0; this may only be set if:</p> <ul style="list-style-type: none">ClkDivisorCstAct0 specifies a divide-by 1, 2, 4, 8, or 16 and NbCof <= 3.2 GHzClkDivisorCstAct0 specifies a divide-by 1, 2, 4, or 8 and NbCof >= 3.4 GHz <p>This bit also specifies functionality of the timer used for cache flushing. See CacheFlushTmrSelCstAct0.</p> <ul style="list-style-type: none">If CpuPrbEnCstAct0=0 and D18F3xDC[IgnCpuPrbEn]=0, only the time when the core is in a non-C0 state and has its clocks ramped up to service probes is counted.If CpuPrbEnCstAct0=1 or D18F3xDC[IgnCpuPrbEn]=1, all of the time the core is in a non-C0 state is counted.																				

D18F4x11C C-state Control 2

Reset: 0000_0000h. Read-write.

Bits	Description
31:14	Reserved.
13	SelfRefrEarly2 . See: D18F4x118[SelfRefrEarly0] .
12	SelfRefr2 . See: D18F4x118[SelfRefr0] .
11	NbClkGate2 . See: D18F4x118[NbClkGate0] .
10	NbPwrGate2 . Read-write. 1=Allow clock-gating of the NB. 0=Prevent clock-gating of the NB. NbClkGate2 must be equal to SelfRefr2. See 2.5.4.2 [NB C-states] .
9	PwrOffEnCstAct2 . See: D18F4x118[PwrOffEnCstAct0] .
8	PwrGateEnCstAct2 . See: D18F4x118[PwrGateEnCstAct0] .
7:5	ClkDivisorCstAct2 . See: D18F4x118[ClkDivisorCstAct0] .
4	Reserved.
3:2	CacheFlushTmrSelCstAct2 . See: D18F4x118[CacheFlushTmrSelCstAct0] .
1	CacheFlushEnCstAct2 . See: D18F4x118[CacheFlushEnCstAct0] .
0	CpuPrbEnCstAct2 . See: D18F4x118[CpuPrbEnCstAct0] .

D18F4x124 C-state Interrupt Control

Bits	Description
31:0	Reserved.

D18F4x128 C-state Policy Control 1

Reset: 0080_0000h.

Bits	Description										
31	CstateMsgDis: C-state messaging disable. Read-write. Specifies whether any messages are sent to the FCH when a core enters or exits a C-state. 0=Messages are sent. 1=Messages are not sent.										
30:25	Reserved.										
24:23	CacheFlushSucMonMispredictAct: cache flush success monitor mispredict action . Read-write. BIOS: 01b. Specifies the cache flush success monitor decrement when non-C0 residency is shorter than duration specified by CacheFlushSucMonTmrSel. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>reset counter to zero</td></tr> <tr> <td>01b</td><td>decrement by 1</td></tr> <tr> <td>10b</td><td>decrement by 2</td></tr> <tr> <td>11b</td><td>decrement by 3</td></tr> </table>	Bits	Description	00b	reset counter to zero	01b	decrement by 1	10b	decrement by 2	11b	decrement by 3
Bits	Description										
00b	reset counter to zero										
01b	decrement by 1										
10b	decrement by 2										
11b	decrement by 3										

22:21	CacheFlushSucMonTmrSel: cache flush success monitor timer select. Read-write. BIOS: 01b. Specifies the non-C0 duration used to increment the cache flush success monitor. <table> <tr> <th>Bits</th><th>Duration</th></tr> <tr> <td>00b</td><td>Use cache flush timer specified by D18F4x11[C:8]</td></tr> <tr> <td>01b</td><td>D18F3xDC[CacheFlushOnHaltTmr]</td></tr> <tr> <td>10b</td><td>D18F4x128[CacheFlushTmr]</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Duration	00b	Use cache flush timer specified by D18F4x11[C:8]	01b	D18F3xDC [CacheFlushOnHaltTmr]	10b	D18F4x128 [CacheFlushTmr]	11b	Reserved
Bits	Duration										
00b	Use cache flush timer specified by D18F4x11[C:8]										
01b	D18F3xDC [CacheFlushOnHaltTmr]										
10b	D18F4x128 [CacheFlushTmr]										
11b	Reserved										
20:18	CacheFlushSucMonThreshold: cache flush success monitor threshold. Read-write. BIOS: 100b. Flush the caches immediately if cache flushing is enabled and the cache flush success monitor count == CacheFlushSucMonThreshold. A value of 0 disables the cache flush success monitor. See D18F4x118/D18F4x11C [CacheFlushEn].										
17:12	Reserved.										
11:5	CacheFlushTmr: cache flush timer. Read-write. BIOS: 28h. Specifies how long each core needs to stay in a C-state before it flushes its caches. See D18F4x118/D18F4x11C [CacheFlushTmrSel]. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td><= 5.12 us</td></tr> <tr> <td>7Fh-01h</td><td>(<CacheFlushTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushTmr> * 10.24 us</td></tr> </table>	Bits	Description	00h	<= 5.12 us	7Fh-01h	(<CacheFlushTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushTmr> * 10.24 us				
Bits	Description										
00h	<= 5.12 us										
7Fh-01h	(<CacheFlushTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushTmr> * 10.24 us										
4:2	HaltCstateIndex. Read-write. BIOS: 0. Specifies the IO-based C-state that is invoked by a HLT instruction.										
1	Reserved.										
0	Reserved.										

D18F4x13C SMU P-state Control

Reset: 0000_0000h. Read-only, updated-by-SMU.

Bits	Description
31:4	Reserved.
3:1	SmuPstateLimit. Specifies the highest-performance P-state (lowest value) allowed. SmuPstateLimit is always bounded by MSRC001_0061 [PstateMaxVal]. This field uses hardware P-state numbering. See MSRC001_0071 [CurPstateLimit] and 2.5.3.1.1.2 [Hardware P-state Numbering] .
0	SmuPstateLimitEn.

D18F4x15C Core Performance Boost Control

Bits	Description										
31	BoostLock. Read-only. Reset: Product-specific. Specifies whether the following registers are Read-write, read-only, or have special requirements related to writability. See individual register definitions for details. <ul style="list-style-type: none"> • MSRC001_00[6B:64][CpuFid, CpuDid, CpuVid]. • D18F4x110[MinResTmr] • D18F4x15C[NumBoostStates]. • D18F4x16C[CstateCnt, CstateBoost]. • D18F4x250[NodeTdpLimit]. 										
30:9	Reserved.										
8	CstatePowerEn: C-state power enable. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. BIOS: 1.										
7	ApmMasterEn: APM master enable. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. BIOS: IF(D18F4x15C [NumBoostStates]==0) THEN 0. ELSE 1. ENDIF. 1=Enables the ability to turn on features associated with APM when used in conjunction with the individual feature enable bits. See 2.5.9 [Application Power Management (APM)] .										
6:5	Reserved.										
4:2	NumBoostStates: number of boosted states. IF (D18F4x15C [BoostLock] ApmMasterEn D18F2x1B4 [SmuCfgLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: Product-specific. Specifies the number of P-states that are considered boosted P-states. See 2.5.9 [Application Power Management (APM)] .										
1:0	BoostSrc: boost source. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. BIOS: 2.5.3.1.6 . Specifies whether CPB is enabled or disabled. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Boosting disabled</td></tr> <tr> <td>01b</td><td>Boosting enabled</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	Boosting disabled	01b	Boosting enabled	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Description</u>										
00b	Boosting disabled										
01b	Boosting enabled										
10b	Reserved										
11b	Reserved										

D18F4x164 Fixed Errata

Bits	Description
31:0	FixedErrata. Value: Product-specific. See the Revision Guide for the definition of this field. See 1.2 [Reference Documents] .

D18F4x16C APM TDP Control

Bits	Description						
31:15	Reserved.						
14	CacUpC1. IF D18F4x15C [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Reset: Product-specific. 1=Cac interface is up on C1 (non XC6) state. 0=Cac interface is down and Cstate scalers are used in place of Cac reads.						
13	CstateCores. IF D18F4x15C [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Reset: Product-specific. Specifies how CstateCnt determines Cstate boost conditions. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>0h</td><td>CstateCnt specifies the number of compute units.</td></tr> <tr> <td>1h</td><td>CstateCnt specifies the number of cores.</td></tr> </table>	Bit	Description	0h	CstateCnt specifies the number of compute units.	1h	CstateCnt specifies the number of cores.
Bit	Description						
0h	CstateCnt specifies the number of compute units.						
1h	CstateCnt specifies the number of cores.						
12	Reserved.						
11:9	CstateCnt: C-state count. IF D18F4x15C [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Reset: Product-specific. Specifies the number of cores or compute units (see CstateCores) that must be in CC6 before a transition can occur to a boosted P-state that is higher performance than the P-state specified by CstateBoost. A value of 0 disables access to P-states above CstateBoost.						
8:6	CstateBoost. Read-write. Reset: Product-specific. Specifies the P-state which requires the number of cores or compute units (see CstateCores) specified in CstateCnt to be in CC6 before a transition to a higher performance (lower numbered) boosted P-state is allowed. CstateBoost must be less than or equal to D18F4x15C [NumBoostStates] otherwise undefined behavior results. If D18F4x15C [BoostLock]=1, CstateBoost can only be written with values that are greater than or equal to the reset value. Attempts to write values less than the reset value are ignored. A value of 0 indicates that the C-state boost feature is not supported. This field uses hardware P-state numbering. See 2.5.3.1.1.2 [Hardware P-state Numbering] .						
5	ApmTdpLimitSts: APM TDP limit status. Read; set-by-hardware; write-1-to-clear. Reset: 0. This bit is set by hardware when D18F5xE8 [ApmTdpLimit] changes.						
4	ApmTdpLimitIntEn: APM TDP limit interrupt enable. Read-write. Reset: 0. BIOS: 1. 1=Enables the generation of an interrupt using APIC330 of each core when D18F5xE8 [ApmTdpLimit] changes.						
3	TdpLimitDis. IF D18F4x15C [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. BIOS: 1. 1=Disables TDP limit checking and allows the processor to transition to higher performance P-states.						
2:0	Reserved.						

D18F4x1C0 Node Cac Register 1

Bits	Description
31:12	Reserved.
11:0	NodeCacLatest. Read-only, updated-by-hardware. Reset: 0. Specifies the sum of all instantaneous power credits on each compute unit. NodeCacLatest is reset to 0 when D18F4x15C [ApmMasterEn]=0.

D18F4x250 TDP Limit 8

Bits	Description
31	Reserved.
30:28	TdpLimitPstate . Read-write. Reset: 0. Specifies the highest performance P-state that has a power consumption less than or equal to the TDP limit. This field is programmed by BIOS and uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering] .
27:12	Reserved.
11:0	NodeTdpLimit . Read-write; Same-for-all . Reset: Product-specific. Specifies the maximum allowed sum of TDPs from all cores on a node. If the consumed power exceeds the NodeTdpLimit, a P-state limit is applied to all cores on the processor to reduce the power consumption so that it remains within the TDP limit. If D18F4x15C[BoostLock] =1, NodeTdpLimit can only be written with values that are less than or equal to the reset value. Attempts to write an invalid value are ignored. See 2.5.9.2 [TDP Limiting] .

3.14 Device 18h Function 5 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

D18F5x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Value: 1585h.
15:0	VendorID: vendor ID. Read-only. Value: 1022h.

D18F5x04 Status/Command

Bits	Description
31:16	Status. Read-only. Value: 0000h.
15:0	Command. Read-only. Value: 0000h.

D18F5x08 Class Code/Revision ID

Bits	Description
31:8	ClassCode. Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification.
7:0	RevID: revision ID. Read-only. Value: 00h.

D18F5x0C Header Type

Bits	Description
31:0	HeaderTypeReg. Read-only. Reset: 0080_0000h. These bits are fixed at their default values. The header type field indicates that there are not multiple functions present in this device.

D18F5x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer. Read-only. Value: 00h.

D18F5x[70,60,50,40] Northbridge Performance Event Select Low

Bits	Description
31:0	MSRC001_024[6,4,2,0][31:0] is an alias of D18F5x[70,60,50,40] .

D18F5x[74,64,54,44] Northbridge Performance Event Select High

Bits	Description
31:0	MSRC001_024[6,4,2,0][63:32] is an alias of D18F5x[74,64,54,44] .

D18F5x[78,68,58,48] Northbridge Performance Event Counter Low

See [2.6.1.3 \[NB Performance Monitor Counters\]](#) for proper read sequence.

Bits	Description
31:0	MSRC001_024[7,5,3,1][31:0] is an alias of D18F5x[78,68,58,48] .

D18F5x[7C,6C,5C,4C] Northbridge Performance Event Counter High

See [2.6.1.3 \[NB Performance Monitor Counters\]](#) for proper read sequence.

Bits	Description
31:0	MSRC001_024[7,5,3,1][63:32] is an alias of D18F5x[7C,6C,5C,4C] .

D18F5x80 Compute Unit Status 1

See [2.4.4 \[Processor Cores and Downcoring\]](#).

Software associates core ID to the cores of the compute units according to the following table. All combinations not listed are reserved.

Table 187: D18F5x80[Enabled, DualCore, TripleCore, QuadCore] Definition

Enabled	DualCore	TripleCore	QuadCore	Definition
1h	xh	xh	1h	1 L2 complex is enabled; four cores of the L2 complex are enabled.
1h	xh	1h	0h	1 L2 complex is enabled; three cores of the L2 complex are enabled.
1h	1h	0h	0h	1 L2 complex is enabled; two cores of the L2 complex are enabled.
1h	0h	0h	0h	1 L2 complex is enabled; one core of the L2 complex are enabled.

Bits	Description										
31:28	Reserved.										
27:24	<p>QuadCore: four cores of a L2 complex are enabled. Read-only. Reset: Product-specific. 1=Four cores of a L2 complex are enabled. See Table 187 [D18F5x80[Enabled, DualCore, TripleCore, QuadCore] Definition].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>L2 complex 0</td></tr> <tr> <td>[1]</td><td>Reserved</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	L2 complex 0	[1]	Reserved	[2]	Reserved	[3]	Reserved
Bit	Description										
[0]	L2 complex 0										
[1]	Reserved										
[2]	Reserved										
[3]	Reserved										

23:20	Reserved.										
19:16	<p>DualCore: two cores of a L2 complex are enabled. Read-only. Reset: Product-specific. 1=Both cores of a L2 complex are enabled. See Table 187 [D18F5x80[Enabled, DualCore, TripleCore, QuadCore] Definition].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>L2 complex 0</td></tr> <tr> <td>[1]</td><td>Reserved</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	L2 complex 0	[1]	Reserved	[2]	Reserved	[3]	Reserved
Bit	Description										
[0]	L2 complex 0										
[1]	Reserved										
[2]	Reserved										
[3]	Reserved										
15:12	Reserved.										
11:8	<p>TripleCore: three cores of a L2 complex are enabled. Read-only. Reset: Product-specific. 1=Three cores of a L2 complex are enabled. See Table 187 [D18F5x80[Enabled, DualCore, TripleCore, QuadCore] Definition].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>L2 complex 0</td></tr> <tr> <td>[1]</td><td>Reserved</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	L2 complex 0	[1]	Reserved	[2]	Reserved	[3]	Reserved
Bit	Description										
[0]	L2 complex 0										
[1]	Reserved										
[2]	Reserved										
[3]	Reserved										
7:4	Reserved.										
3:0	<p>Enabled: at least one core of a L2 complex is enabled. Read-only. Reset: Product-specific. 1=At least one core is enabled in a L2 complex. See Table 187 [D18F5x80[Enabled, DualCore, TripleCore, QuadCore] Definition].</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>L2 complex 0</td></tr> <tr> <td>[1]</td><td>Reserved</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	L2 complex 0	[1]	Reserved	[2]	Reserved	[3]	Reserved
Bit	Description										
[0]	L2 complex 0										
[1]	Reserved										
[2]	Reserved										
[3]	Reserved										

D18F5x84 Northbridge Capabilities 2

Unless otherwise specified, 1=The feature is supported by the processor; 0=The feature is not supported.

Bits	Description
31:29	Reserved.
28:24	<p>DdrMaxRateEnf: enforced maximum DDR rate. Read-only. Value: Product-specific. See: DdrMaxRate. Specifies the maximum DRAM data rate that the processor is designed to support. Writes to D18F2x94_dct[0][MemClkFreq] that specify a frequency greater than specified by DdrMaxRateEnf will result in the D18F2x94_dct[0][MemClkFreq] being set to DdrMaxRateEnf.</p>
23:21	Reserved.
20:16	<p>DdrMaxRate: maximum DDR rate. Read-only. Value: Product-specific. Specifies the maximum DRAM data rate that the processor is designed to support. DdrMaxRate is defined by Table 136 [Valid Values for Memory Clock Frequency Value Definition]; except that 00h is defined as no limit. See D18F2x94_dct[0][MemClkFreq], and DdrMaxRateEnf.</p>

15:12	DctEn[3:0]: DCT[3:0] enabled. Read-only. Value: Product-specific. Specifies which DCT controllers are enabled. 1=Enabled. 0=Disabled. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>DCT 0</td></tr> <tr> <td>[3:1]</td><td>Reserved</td></tr> </table>	Bit	Description	[0]	DCT 0	[3:1]	Reserved
Bit	Description						
[0]	DCT 0						
[3:1]	Reserved						
11:8	Reserved.						
7:0	CmpCap: CMP capable. Read-only. Value: Product-specific. Number of cores on the node is CmpCap+1. CmpCap does not reflect cores disabled by D18F3x190 [DisCore].						

D18F5x88 NB Configuration 4 (NB_CFG4)

Bits	Description
31:25	Reserved.
24	DisHbNpReqBusLock. Read-write. Reset: 0. BIOS: 1. 0=While bus locks are in progress, all non-posted commands from I/O, including atomics, are blocked until the core has completed the locked transaction and releases the bus. 1=All non-posted commands except atomics do not honor bus locks and are allowed to proceed. This bit may be set to achieve better DMA performance in the presence of bus locks.
23:21	Reserved.
20	Reserved.
19	Reserved.
18	EnCstateBoostBlockCC6Exit. Read-write. Reset: 0. BIOS: 1. 1=Cores cannot exit CC6 until VDD is less than or equal to the voltage of the P-state indexed by D18F4x16C [CstateBoost].
17:15	Reserved.
14	DisHldRegRdRspChk. Read-write. Reset: 0. 1=Disable primary holding register CPU or I/O read response checks.
13:1	Reserved.
0	CC6PstateWakeUpDis. Read-write. Reset: 0. BIOS: 1. 1=Disable waking up cores in CC6 for P-state changes. 0=Wakeup cores in CC6 for a P-state change to the PopDownPstate, and then return the core to CC6.

D18F5x8C NB Configuration 5 (NB_CFG5)

Bits	Description
31:27	Reserved.
26:16	Reserved.
15	EnSrqAllocGt31. Read-write. Cold reset: 0b. BIOS: 1. 1=Enables allocation of SRA entries to above the lower 32 entries.
14:2	Reserved.
1	Reserved.
0	Reserved.

D18F5xE0 Processor TDP Running Average

Bits	Description
31:4	Reserved.
3:0	RunAvgRange: running average range. Read-write; Same-for-all . Reset: 0. BIOS: 1h. Specifies the interval over which the processor averages power consumption estimates from the cores for boosting. Time interval = $2^{(\text{RunAvgRange} + 1)} * \text{FreeRunSampleTimer}$ rate. A value of 0 disables the TDP running average accumulator capture function. See 2.5.9 [Application Power Management (APM)] .

D18F5xE8 TDP Limit 3

Bits	Description
31:29	Reserved.
28:16	ApmTdpLimit. Read-only; updated-by-hardware. Value: D18F4x250[NodeTdpLimit] . If the consumed node power exceeds the ApmTdpLimit on an single node processor or the ApmTdpLimit/2 on a multi-node processor, a P-state limit is applied to all cores on all nodes to reduce the power consumption to remain within the TDP limit. See 2.5.9.2 [TDP Limiting] .
15:10	Tdp2Watt[5:0]. Read-only. Value: Product-specific. See Tdp2Watt[15:6].
9:0	Tdp2Watt[15:6]. Read-only. Value: Product-specific. Specifies in watts/TDP units the conversion factor for converting TDP units to watts. Tdp2Watt[15:0] is a fixed point integer with 16 bits to the right of the decimal point and 0 bits to the left of the decimal point. E.g. Tdp2Watt[15]==0.5 W; Tdp2Watt[6]==0.976 mW; Tdp2Watt[0]==15.2 uW.

D18F5xEC Load Step Throttle Control

Bits	Description
31:0	Reserved.

D18F5x128 Clock Power/Timing Control 3

Bits	Description
31	Reserved.
30	NbFidChgCpuOpEn. Read-write. Cold reset: 0b.
29:28	Reserved.
27	SprSaveRestoreEn. Read-write. Cold Reset:0. BIOS: 1. Enables SPR save/restore for non-retention NB power gating.
26:23	Reserved.
22	NbPlPwrDwnRegEn: NB PLL power down. Read-write. Cold reset: Product-specific. 1=The NB PLL is powered down when the NB is power gated and DRAM is placed into self-refresh (see 2.5.4.2 [NB C-states]). 0=The NB PLL is not powered down during NB C-states.
21	PC6Vid[7]. Read-write. Cold reset: Product-specific. See PC6Vid[6:0].
20:16	Reserved.

15	CC6PwrDwnRegEn: CC6 power down regulator enable. Read-write. Cold reset: Product-specific. 1=Power down the VDDA regulator on CC6 entry. See PllRegTime.															
14	PC6PwrDwnRegEn: PC6 power down regulator enable. Read-write. Cold reset: Product-specific. 1=Power down the VDDA regulator on PC6 entry. See PllRegTime.															
13:12	PwrGateTmr: power gate timer. Read-write. Cold reset: 01b. BIOS: 00b. Specifies the minimum delay time required from the power gating or ungating of one Core to the power gating or ungating of the same Core or another Core. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>500 ns</td><td>10b</td><td>Reserved.</td></tr><tr><td>01b</td><td>1 us</td><td>11b</td><td>Reserved.</td></tr></table>				<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	00b	500 ns	10b	Reserved.	01b	1 us	11b	Reserved.
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>													
00b	500 ns	10b	Reserved.													
01b	1 us	11b	Reserved.													
11:10	PllVddOutUpTime. Read-write. Cold reset: 0. The VDD regulator may be powered down when the processor transitions to PC6. If the regulator is powered down, this field specifies the time required to initialize the core PLL logic once the regulator is powered back up. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>100 ns</td><td>10b</td><td>400 ns</td></tr><tr><td>01b</td><td>200 ns</td><td>11b</td><td>800 ns</td></tr></table>				<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	00b	100 ns	10b	400 ns	01b	200 ns	11b	800 ns
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>													
00b	100 ns	10b	400 ns													
01b	200 ns	11b	800 ns													
9	FastSlamTimeDown. Read-write. Cold reset: 0. BIOS: 1. Specifies the time the processor waits for downward voltage transitions to complete. This field only effects transitions from D18F4x16C [CstateBoost] or lower performance P-states. 0= D18F3xD8 [VSRampSlamTime] . 1=10 us.															
8:7	PllRegTime: Pll regulator time. Read-write. Cold reset: 10b. The VDDA regulator may be powered down when the processor transitions to PC6 or CC6. See PC6PwrDwnRegEn and CC6PwrDwnRegEn. If CC6PwrDwnRegEn=1, the VDDA regulator is powered down during CC6. If PC6PwrDwnRegEn=1, the VDDA regulator is powered down during PC6. If the VDDA regulator is powered down during CC6 and the core transitions from CC6 to PC6, the regulator remains powered down during PC6 regardless of the PC6PwrDwnRegEn setting. This field specifies the time required for the VDDA regulator to power back up and initialize the core PLL logic that is powered by the VDDA regulator. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>Reserved.</td><td>10b</td><td>1.5 us</td></tr><tr><td>01b</td><td>Reserved.</td><td>11b</td><td>2.0 us</td></tr></table>				<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	00b	Reserved.	10b	1.5 us	01b	Reserved.	11b	2.0 us
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>													
00b	Reserved.	10b	1.5 us													
01b	Reserved.	11b	2.0 us													
6:0	PC6Vid[6:0]: package C6 vid. Read-write. Cold reset: Product-specific. PC6Vid[7:0] = {PC6Vid[7], PC6Vid[6:0]}. PC6Vid[7:0] specifies the VID driven in the PC6 state. See 2.5.3.2.3.4 [Package C6 (PC6) State] and 2.5.1.3.2 [Low Power Voltages] .															

D18F5x12C Clock Power/Timing Control 4

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

Bits	Description
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31	Svi2CmdBusy. Read-only; updated-by-hardware. Cold reset: 0. 1=SVI2 command in progress. This bit is set by hardware when any SVI2 command is sent to the voltage regulator. Software must wait for this bit to clear to 0 before writing any of the following fields: D18F5x12C [CorePsi1En, CoreLoadLineTrim, CoreOffsetTrim], D18F5x188 [NbPsi1, NbLoadLineTrim, NbOffsetTrim], D18F5x18C [CoreTfn, NbTfn]. This bit is cleared by hardware when the SVI2 command is complete. On a voltage change, this bit is cleared when the voltage transition is completed. See 2.5.1.4.1 [Hardware-Initiated Voltage Transitions] . On a telemetry or PSIx_L change, this bit is cleared as soon as the SVI2 command is sent to the voltage regulator. See 2.5.1.1.1 [SVI2 Features] and 2.5.1.3.1 [PSIx_L Bit] .																				
30	WaitVidCompDis: wait VID completion disable. IF (D18F2x1B4 [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 0. 0=Hardware waits for the VOTF complete indicator from the voltage regulator before clearing Svi2CmdBusy or making additional voltage change requests. 1=Hardware clears Svi2CmdBusy 500us after changes to CoreLoadLineTrim, CoreOffsetTrim, or D18F5x188 [NbLoadLineTrim, NbOffsetTrim] are made; hardware clears Svi2CmdBusy and additional voltage changes are allowed after the time specified by D18F3xD8 [VSRampSlamTime] . See 2.5.1.4 [Voltage Transitions] .																				
29:6	RAZ.																				
5	CorePsi1En: Core PSI1_L enable. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. BIOS: 1. 0=PSI1_L for VDD is deasserted. 1=PSI1_L for VDD is asserted when all cores are in CC6. See 2.5.3.2.3.4 [Package C6 (PC6) State] , 2.5.1.3.1 [PSIx_L Bit] , and Svi2CmdBusy.																				
4:2	CoreLoadLineTrim: Core load line trim. IF (D18F2x1B4 [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 011b. CoreLoadLineTrim and NbLoadLineTrim specify a percentage change relative to the initial load line slope for VDD and VDDNB, respectively. See Svi2CmdBusy. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>Load line disabled</td><td>100b</td><td>+20%</td></tr><tr><td>001b</td><td>-40%</td><td>101b</td><td>+40%</td></tr><tr><td>010b</td><td>-20%</td><td>110b</td><td>+60%</td></tr><tr><td>011b</td><td>0%</td><td>111b</td><td>+80%</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	000b	Load line disabled	100b	+20%	001b	-40%	101b	+40%	010b	-20%	110b	+60%	011b	0%	111b	+80%
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																		
000b	Load line disabled	100b	+20%																		
001b	-40%	101b	+40%																		
010b	-20%	110b	+60%																		
011b	0%	111b	+80%																		
1:0	CoreOffsetTrim: Core offset trim. IF (D18F2x1B4 [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 10b. CoreOffsetTrim and NbOffsetTrim specify a voltage offset relative to the initial load line offset for VDD and VDDNB, respectively. See Svi2CmdBusy. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>Load line offset disabled</td><td>10b</td><td>0mV</td></tr><tr><td>01b</td><td>-25mV</td><td>11b</td><td>+25mV</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	00b	Load line offset disabled	10b	0mV	01b	-25mV	11b	+25mV								
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																		
00b	Load line offset disabled	10b	0mV																		
01b	-25mV	11b	+25mV																		

D18F5x16[C:0] Northbridge P-state [3:0]

Each of these registers specify the frequency and voltage associated with each of the NB P-states.

Table 188: Register Mapping for [D18F5x16\[C:0\]](#)

Register	Function
D18F5x160	NB P-state 0
D18F5x164	NB P-state 1
D18F5x168	NB P-state 2
D18F5x16C	NB P-state 3

The NbVid field is allowed to be different between processors in a multi-processor system. All other fields are required to be programmed to the same value for all processors in the coherent fabric. See [2.5.4.1 \[NB P-states\]](#) for more information about these registers.

Table 189: NB P-state Definitions

Term	Definition
NBCOF	NB current operating frequency in MHz. $NBCOF = 100 * (D18F5x16[C:0][NbFid] + 4h) / (2^{D18F5x16[C:0][NbDid]})$.
NBCOF[0]	NB current operating frequency in MHz for NB P-state 0. $NBCOF[0] = (100 * (D18F5x160[NbFid] + 4h) / (2^{D18F5x160[NbDid]}))$.
NBCOF[1]	NB current operating frequency in MHz for NB P-state 1. $NBCOF[1] = (100 * (D18F5x164[NbFid] + 4h) / (2^{D18F5x164[NbDid]}))$.
NBCOF[2]	NB current operating frequency in MHz for NB P-state 2. $NBCOF[2] = (100 * (D18F5x168[NbFid] + 4h) / (2^{D18F5x168[NbDid]}))$.
NBCOF[3]	NB current operating frequency in MHz for NB P-state 3. $NBCOF[3] = (100 * (D18F5x16C[NbFid] + 4h) / (2^{D18F5x16C[NbDid]}))$.

Bits	Description										
31:24	NbIddValue: northbridge current value. Read-write. Cold reset: Product-specific. See NbIddDiv.										
23:22	NbIddDiv: northbridge current divisor. Read-write. Cold reset: Product-specific. After reset, NbIddDiv and NbIddValue combine to specify the expected maximum current drawn on the VDDNB power plane at a given VDDNB voltage. These values are intended to be used by 2.5.1.3.1.1 [BIOS Requirements for PSIO_L] . These values are not intended to convey final product power levels and may not match the power levels specified in the Power and Thermal Datasheet. These fields may be subsequently altered by software; they do not affect the hardware behavior.										
	<table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>IddValue / 1 A, Range: 0 to 255 A.</td></tr> <tr> <td>01b</td><td>IddValue / 10 A, Range: 0 to 25.5 A.</td></tr> <tr> <td>10b</td><td>IddValue / 100 A, Range: 0 to 2.55 A.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Description	00b	IddValue / 1 A, Range: 0 to 255 A.	01b	IddValue / 10 A, Range: 0 to 25.5 A.	10b	IddValue / 100 A, Range: 0 to 2.55 A.	11b	Reserved.
Bits	Description										
00b	IddValue / 1 A, Range: 0 to 255 A.										
01b	IddValue / 10 A, Range: 0 to 25.5 A.										
10b	IddValue / 100 A, Range: 0 to 2.55 A.										
11b	Reserved.										
21	NbVid[7]. Read-write. Cold reset: Product-specific. See NbVid[6:0].										
20	Reserved.										
19	Reserved.										
18	MemPstate: Memory P-state. Read-write. Cold reset: Product-specific. 1=The Northbridge P-state specified by this register maps to memory P-state 1. 0=The Northbridge P-state specified by this register maps to memory P-state 0. Memory P-states may be globally disabled by programming D18F5x170[MemPstateDis] . See 2.5.7.1 [Memory P-states] .										
17	Reserved.										
16:10	NbVid[6:0]: Northbridge VID. Read-write. Cold reset: Product-specific. $NbVid[7:0] = \{NbVid[7], NbVid[6:0]\}$. NbVid[7:0] specifies the Northbridge voltage.										
9:8	Reserved.										

7	NbDid: Northbridge divisor ID. Read-write. Cold reset: Product-specific. Specifies the Northbridge frequency divisor. See NbFid[5:0].
6:1	NbFid[5:0]: Northbridge frequency ID. Read-write. Cold reset: Product-specific. Specifies the Northbridge frequency multiplier. The NB COF is a function of NbFid and NbDid, and defined by NBCOF . NbFid and NbDid are not changed on a write if the value written results in a frequency greater than MSRC001_0071 [MaxNbCof]. See 2.5.3.1.5 [Core P-state Transition Behavior].
0	NbPstateEn: Northbridge P-state enable. Read-write. Cold reset: Product-specific. 1=The Northbridge P-state specified by this register is valid. 0=The Northbridge P-state specified by this register is not valid. This bit must be set to 1 in order for the Northbridge P-state specified by this register to be programmed in D18F5x170 [NbPstateHi, NbPstateLo].

D18F5x170 Northbridge P-state Control

See also 2.5.4.1 [NB P-states].

Bits	Description																				
31	MemPstateDis: memory P-state disable. IF (D18F3xE8[MemPstateCap] && D18F2x1B4[SmuCf-gLock]==0) THEN Read-write; updated-by-hardware; Updated-by-SMU. ELSE Read-only; updated-by-hardware; Updated-by-SMU. Reset: Product-specific. 1=Memory P-state transitions are disabled. The current P-state is not changed by programming this bit. The memory P-state will be forced to M0 on the next NB P-state transition. On processors where memory P-states are enabled, programming this bit may result in a violation of bandwidth requirements stated in 2.5.3.1.5 . Software must ensure that NB P-states which violate those requirements are forced disabled. 0=Memory P-state transitions are enabled if D18F2x90_dct[0][DisDllShutdownSR]=0.																				
30	NbPstateFidVidSbcEn. IF (D18F5x174[NbPstateDis] D18F2x1B4[SmuCf-gLock]) THEN Read-only. ELSE Read: Write-1-only. ENDIF. Reset: 0. BIOS: 1. NB P-state transitions are blocked until this field is set to a 1.																				
29:27	NbPstateHiRes: NB P-state high residency timer. If D18F2x1B4[SmuCf-gLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies the minimum time the processor must spend in the high NB P-state before transitions to the low NB P-state are allowed. See 2.5.4.1 [NB P-states]. <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>000b</td><td>0us</td><td>100b</td><td>1ms</td></tr><tr><td>001b</td><td>10us</td><td>101b</td><td>5ms</td></tr><tr><td>010b</td><td>100us</td><td>110b</td><td>10ms</td></tr><tr><td>011b</td><td>500us</td><td>111b</td><td>50ms</td></tr></table>	Bits	Description	Bits	Description	000b	0us	100b	1ms	001b	10us	101b	5ms	010b	100us	110b	10ms	011b	500us	111b	50ms
Bits	Description	Bits	Description																		
000b	0us	100b	1ms																		
001b	10us	101b	5ms																		
010b	100us	110b	10ms																		
011b	500us	111b	50ms																		
26:24	NbPstateLoRes: NB P-state low residency timer. If D18F2x1B4[SmuCf-gLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies the minimum time the processor must spend in the low NB P-state before transitions to the high NB P-state are allowed. See 2.5.4.1 [NB P-states]. See: NbPstateHiRes.																				
23	NbPstateGnbSlowDis. If D18F2x1B4[SmuCf-gLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies whether NBP-state transitions take the GnbSlow signal into account. 0=Take GnbSlow into account. 1=Ignore GnbSlow. See 2.5.4.1 [NB P-states].																				
22:15	Reserved.																				
14	SwNbPstateLoDis: software NB P-state low disable. IF (D18F5x174[NbPstateDis] D18F2x1B4[SmuCf-gLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Transition to NbPstateHi and disable transitions to NbPstateLo.																				

13	NbPstateDisOnP0: NB P-state disable on P0. IF (D18F5x174[NbPstateDis] D18F2x1B4[SmuCfgLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Transition to NbPstateHi and disable transitions to NbPstateLo if any compute unit is in P0 or a boosted P-state. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].
12:9	NbPstateThreshold: NB P-state threshold. If D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Reset: Product-specific. BIOS: COUNT(D18F5x80[Enabled]) . Specifies the minimum number of compute units that must be in a P-state with MSRC001_00[6B:64][NbPstate]=1 before transitions to lower performance NB P-states are allowed. See NbPstateLo and NbPstateHi.
8	Reserved.
7:6	NbPstateHi: NB P-state high. IF (D18F2x1B4[SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: Product-specific. If NB P-states are enabled, this field specifies the NB P-state that is used when the number of compute units in a P-state with MSRC001_00[6B:64][NbPstate]=1 is less than NbPstateThreshold. This field must be programmed to the same value for all processors in the coherent fabric. This field is not changed on a write if the value written is greater than the NbPstateMaxVal value written or greater than the current NbPstateLo value. See also NbPstateDisOnP0, SwNbPstateLoDis, NbPstateLo, D18F5x174[NbPstateDis], and D18F5x16[C:0][NbPstateEn].
5	Reserved.
4:3	NbPstateLo: NB P-state low. IF (D18F2x1B4[SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: Product-specific. If NB P-states are enabled, this field specifies the NB P-state that is used when the number of compute units in a P-state with MSRC001_00[6B:64][NbPstate]=1 is greater than or equal to NbPstateThreshold. NbPstateLo must be greater than or equal to NbPstateHi. This field must be programmed to the same value for all processors in the coherent fabric. This field is not changed on a write if the value written is greater than the NbPstateMaxVal value written or less than the current NbPstateHi value. See also NbPstateDisOnP0, SwNbPstateLoDis, D18F5x174[NbPstateDis], and D18F5x16[C:0][NbPstateEn].
2	Reserved.
1:0	NbPstateMaxVal: NB P-state maximum value. IF (D18F2x1B4[SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: specified by the reset state of D18F5x16[C:0][NbPstateEn]; the cold reset value is the highest NB P-state number corresponding to the register in which NbPstateEn is set (e.g., if D18F5x160 and D18F5x164 have this bit set and the others do not, then NbPstateMaxVal=1; if NbPstateEn is only set in D18F5x160, then NbPstateMaxVal=0). This specifies the highest NB P-state value (lowest performance state) supported by the hardware.

D18F5x174 Northbridge P-state Status

Bits	Description
31:25	Reserved.
24	CurMemPstate: current memory P-state. Read-only; updated-by-hardware. Reset: 0. Specifies the current memory P-state. 1=Memory P-state 1. 0=Memory P-state 0. See 2.5.7.1 [Memory P-states].
23	CurNbVid[7]: current northbridge voltage ID[7]. MSRC001_0071[CurNbVid[7]] is an alias of D18F5x174[CurNbVid[7]]. . VDDNB voltage.
22	CurNbPstateLo. Read-only; updated-by-hardware. Reset: 0. 1=Current NB Pstate maps to D18F5x170[NbPstateLo]. 0=Current NB Pstate maps to D18F5x170[NbPstateHi].

21	Reserved.								
20:19	<p>CurNbPstate: current northbridge P-state. Read-only; updated-by-hardware. Reset: 0. Provides the NB P-state that corresponds to the current frequency component of the NB. The value of this field is updated when the COF transitions to a new value associated with an NB P-state.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>NB P0</td></tr> <tr> <td>01b</td><td>NB P1</td></tr> <tr> <td>1xb</td><td>Reserved</td></tr> </table>	Bits	Description	00b	NB P0	01b	NB P1	1xb	Reserved
Bits	Description								
00b	NB P0								
01b	NB P1								
1xb	Reserved								
18:12	CurNbVid[6:0]: current northbridge voltage ID. MSRC001_0071 [CurNbVid[6:0]] is an alias of D18F5x174 [CurNbVid[6:0]]. VDDNB voltage.								
11	Reserved.								
10	Reserved.								
9	CurNbDid: current northbridge divisor ID. Read-only; updated-by-hardware. Reset: 0.								
8:3	CurNbFid[5:0]: current northbridge frequency ID. Read-only; updated-by-hardware. Reset: 0.								
2:1	StartupNbPstate: startup northbridge P-state number. Read-only. Cold reset: Product-specific. Specifies the cold reset VID, FID and DID for the Northbridge based on the NB P-state number selected.								
0	NbPstateDis: northbridge P-state disable. Read-only. Value: Product-specific. MSRC001_0071 [NbPstateDis] is an alias of D18F5x174 [NbPstateDis].								

D18F5x178 Northbridge Fusion Configuration

Bits	Description
31:20	Reserved.
19	SwGfxDis. Read-write. Reset: 1. BIOS: IF (GpuEnabled) THEN 0 ELSE 1 ENDIF. 1=Hardware handshakes for NB P-state transitions and DRAM self-refresh entry are ignored. See 2.5.4.1.1 [NB P-state Transitions] . See 2.5.7.2 [DRAM Self-Refresh] .
18	CstateFusionHsDis: C-state fusion handshake disable. Read-write. Reset: 0. BIOS: 1. 1=Ignore the FCH handshake response for PC6 transitions. 0=Use the FCH handshake response for PC6 entry.
17	Dis2ndGnbAllowPsWait. Read-write. Reset: 0. BIOS: 1. 1=Do not do a second check of AllowNb-Trans after quiescing the cores when transitioning NB P-states. See 2.5.4.1.1 [NB P-state Transitions] .
16	ProcHotToGnbEn. Read-write. Reset: 0. BIOS: 1. 1=The GPU is placed into a low-power state when PROCHOT_L is asserted. Note: the GPU power-state transitions associated with PROCHOT_L nominally occur every 1 millisecond; PROCHOT_L assertions and deassertions for less than this period may not result in GPU state changes.
15:12	Reserved.
11	AllowSelfRefrS3Dis: allow self-refresh S3 disable. Read-write. Reset: 0. BIOS: 1. 1=The NB does not wait for handshake before placing DRAM into self-refresh (see 2.5.7.2 [DRAM Self-Refresh]) on S3 entry (see 2.5.8.1.1 [ACPI Suspend to RAM State (S3)]). 0=The NB waits for handshake before placing DRAM into self-refresh on S3 entry.

10	InbWakeS3Dis: InbWake S3 disable. Read-write. Reset: 0. BIOS: 1. 1= The NB does not wait for handshake before placing DRAM into self-refresh (see 2.5.7.2 [DRAM Self-Refresh]) on S3 entry (see 2.5.8.1.1 [ACPI Suspend to RAM State (S3)]). 0=The NB waits for handshake before placing DRAM into self-refresh on S3 entry.
9:4	Reserved.
3	CstateThreeWayHsEn: C-state three way handshake disable. Read-write. Reset: 0. 1=Enable the three way handshake with the FCH when entering a C-state. 0=Only a two way handshake with FCH is used. There is no message about the resulting package state sent to FCH.
2	CstateFusionDis: C-state fusion disable. Read-write. Reset: 0. 1=All HALT or C-state requests are forwarded to the FCH. 0=HALT and C-state requests are forwarded to the FCH when each core has made a request.
1:0	Reserved.

D18F5x17C Miscellaneous Voltages

Bits	Description
31	NbPsi0VidEn: Northbridge PSI0_L VID enable. Read-write. Reset: 0. This bit specifies how PSI0_L is controlled for VDDNB. See D18F3xA0[PsiVidEn] and 2.5.1.3.1 [PSIx_L Bit] .
30:23	NbPsi0Vid[7:0]: Northbridge PSI0_L VID threshold. Read-write. Reset: 0. When enabled by NbPsi0VidEn, NbPsi0Vid specifies the threshold value of the VID code generated by the Northbridge, which in turn determines the state of PSI0_L. See D18F3xA0[PsiVid[6:0]] and 2.5.1.3.1 [PSIx_L Bit] .
22:18	Reserved.
17:10	MinVid: minimum voltage. Read-only. Reset: Product-specific. Specifies the VID code corresponding to the minimum voltage (highest VID code) that the processor drives. 00h indicates that no minimum VID code is specified. See 2.5.1 [Processor Power Planes And Voltage Control] .
9:8	Reserved.
7:0	MaxVid: maximum voltage. Read-only. Reset: Product-specific. Specifies the VID code corresponding to the maximum voltage (lowest VID code) that the processor drives. 00h indicates that no maximum VID code is specified. See 2.5.1 [Processor Power Planes And Voltage Control] .

D18F5x188 Clock Power/Timing Control 5

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

Bits	Description
31:6	RAZ.
5	NbPsi1: Northbridge PSI1_L. IF D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. Specifies how PSI1_L is controlled for VDDNB. 1=PSI1_L is low. 0=PSI1_L is high. See 2.5.1.3.1 [PSIx_L Bit] .
4:2	NbLoadLineTrim: Northbridge load line trim. IF D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 011b. See D18F5x12C[CoreLoadLineTrim] .
1:0	NbOffsetTrim: Northbridge offset trim. IF D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 10b. See D18F5x12C[CoreOffsetTrim] .

D18F5x18C Clock Power/Timing Control 6

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

Bits	Description															
31:2	RAZ.															
1	CoreTfn: Core telemetry functionality. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. BIOS: 1. See NbTfn.															
0	NbTfn: Northbridge telemetry functionality. If D18F2x1B4 [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 0. See D18F5x12C [Svi2CmdBusy]. CoreTfn and NbTfn specify the telemetry mode as follows: <table><tr><th><u>CoreTfn</u></th><th><u>NbTfn</u></th><th><u>Description</u></th></tr><tr><td>0</td><td>0</td><td>Telemetry enabled in voltage-only mode.</td></tr><tr><td>0</td><td>1</td><td>Telemetry enabled in voltage and current mode.</td></tr><tr><td>1</td><td>0</td><td>Telemetry disabled.</td></tr><tr><td>1</td><td>1</td><td>Reserved.</td></tr></table>	<u>CoreTfn</u>	<u>NbTfn</u>	<u>Description</u>	0	0	Telemetry enabled in voltage-only mode.	0	1	Telemetry enabled in voltage and current mode.	1	0	Telemetry disabled.	1	1	Reserved.
<u>CoreTfn</u>	<u>NbTfn</u>	<u>Description</u>														
0	0	Telemetry enabled in voltage-only mode.														
0	1	Telemetry enabled in voltage and current mode.														
1	0	Telemetry disabled.														
1	1	Reserved.														

D18F5x194 Name String Address Port

[D18F5x194](#) and [D18F5x198](#) provide BIOS with a read-only name string that may be copied to [MSRC001_00](#)[35:30] at warm reset. Each of [D18F5x198_x](#)[B:0] is read as follows:

1. Write [D18F5x194](#)[Index].
2. Read [D18F5x198](#).

Bits	Description						
31:4	Reserved.						
3:0	Index: name string register index. Read-write. Reset: 0. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>Bh-0h</td><td>Name String Registers. See D18F5x198_x[B:0].</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	Bh-0h	Name String Registers. See D18F5x198_x [B:0].	Fh-Ch	Reserved
<u>Bits</u>	<u>Description</u>						
Bh-0h	Name String Registers. See D18F5x198_x [B:0].						
Fh-Ch	Reserved						

D18F5x198 Name String Data Port

See [D18F5x194](#) for register access information. Address: [D18F5x194](#)[Index].

Bits	Description
31:0	Data. Reset: 0.

D18F5x198_x[B:0] Name String Data

Bits	Description
31:24	NameStringByte3: name string ASCII character 3. Read-only. Value: Product-specific.
23:16	NameStringByte2: name string ASCII character 2. Read-only. Value: Product-specific.
15:8	NameStringByte1: name string ASCII character 1. Read-only. Value: Product-specific.
7:0	NameStringByte0: name string ASCII character 0. Read-only. Value: Product-specific.

D18F5x240 ECC Exclusion Base Address Low

- Transaction addresses are within the defined range if:
EccExclBaseAddr[47:6] <= address[47:6] <= EccExclLimitAddr[47:6].
- BIOS must quiesce all other forms of DRAM traffic when configuring this range. See [MSRC001_001F](#)[Dis-DramScrub].
- When initializing the base/limit pair, the BIOS must write the limit register before the EccExclEn bit is set. BIOS should clear EccExclEn before changing the address range.
- BIOS should re-initialize memory with valid ECC when resizing this region.

Bits	Description
31:6	EccExclBaseAddr[31:6]: ECC exclusion base address register bits[31:6]. Read-write. Reset: 0. EccExclBaseAddr[47:6]={ D18F5x244 [EccExclBaseAddr[47:32]], EccExclBaseAddr[31:6]}. The ECC Exclusion Base/Limit Address registers setup a contiguous range in DRAM where ECC check and error reporting is disabled. BIOS configures the ECC exclusion range code to cover the frame buffer region in ECC UMA systems with internal GPUs. The GPU is configured as MC_SHARED:MC_VM_STEERING [DEFAULT_STEERING]=1 (system traffic to onion).
5:1	Reserved.
0	EccExclEn. Read-write. Reset: 0. 1=Enable ECC Exclusion Range. See D18F5x240 [EccExclBase-Addr].

D18F5x244 ECC Exclusion Base Address High

Bits	Description
31:16	Reserved.
15:0	EccExclBaseAddr[47:32]: ECC exclusion base address register bits[47:32]. Read-write. Reset: 0. See D18F5x240 [EccExclBaseAddr].

D18F5x248 ECC Exclusion Limit Address Low

Bits	Description
31:6	EccExclLimitAddr[31:6]: ECC exclusion limit address register bits[31:6]. Read-write. Reset: 0. EccExclLimitAddr[47:6]={ D18F5x24C [EccExclLimitAddr[47:32]], EccExclLimitAddr[31:6]}. See D18F5x240 [EccExclBaseAddr].
5:0	Reserved.

D18F5x24C ECC Exclusion Limit Address High

Bits	Description
31:16	Reserved.
15:0	EccExclLimitAddr[47:32]: ECC exclusion limit address register bits[47:32]. Read-write. Reset: 0. See D18F5x240 [EccExclBaseAddr].

D18F5x260 Clock Power/Timing Control 8

Bits	Description
31:4	Reserved.
3:0	Reserved.

3.15 IOMMU Memory Mapped Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.12.1 [IOMMU Configuration Space].

IOMMUx00 Device Table Base Address Low

Bits	Description
31:12	DevTblBase[31:12]: device table base address bits[31:12]. Read-write. Reset: 0. DevTblBase[51:12] = {IOMMUx04[DevTblBase[51:32], DevTblBase[31:12]]}. DevTblBase[51:12] specifies the 4Kbyte-aligned base address of the first level device table.
11:9	Reserved.
8:0	DevTblSize: device table size. Read-write. Reset: 0. This field contains 1 less than the length of the device table, in multiples of 4K bytes. A minimum size of 0 corresponds to a 4K byte device table and a maximum size of 1FFh corresponds to a 2M byte device table.

IOMMUx04 Device Table Base Address High

Bits	Description
31:20	Reserved.
19:0	DevTblBase[51:32]: device table base address bits[51:32]. See: IOMMUx00[DevTblBase[31:12]].

IOMMUx08 Command Buffer Base Address Low

Bits	Description
31:12	ComBase[31:12]: command buffer base address bits[31:12]. Read-write. Reset: 0. ComBase[51:12] = {IOMMUx0C[ComBase[51:32], ComBase[31:12]]}. ComBase[51:12] specifies the 4Kbyte-aligned base address of the command buffer.
11:0	Reserved.

IOMMUx0C Command Buffer Base Address High

Bits	Description						
31:28	Reserved.						
27:24	ComLen: command buffer length. Read-write. Reset: 8h. Specifies the length of the command buffer in power of 2 increments. The minimum size is 256 entries (4K bytes); values less than 8h are reserved. <table data-bbox="284 1690 1023 1795"> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td>2^{ComLen} entries (2^{ComLen}*16 bytes).</td></tr> </table>	Bits	Description	7h-0h	Reserved.	Fh-8h	2 ^{ComLen} entries (2 ^{ComLen} *16 bytes).
Bits	Description						
7h-0h	Reserved.						
Fh-8h	2 ^{ComLen} entries (2 ^{ComLen} *16 bytes).						
23:20	Reserved.						
19:0	ComBase[51:32]: command buffer base address bits[51:32]. See: IOMMUx08[ComBase[31:12]].						

IOMMUx10 Event Log Base Address Low

Bits	Description
31:12	EventBase[31:12]: event log base address bits[31:12] . Read-write. Reset: 0. EventBase[51:12] = {IOMMUx14[EventBase[51:32], EventBase[31:12]]}. EventBase[51:12] specifies the 4K-byte aligned base address of the event log.
11:0	Reserved.

IOMMUx14 Event Log Base Address High

Bits	Description						
31:28	Reserved.						
27:24	EventLen: event log length . Read-write. Reset: 8h. Specifies the length of the event log in power of 2 increments. The minimum size is 256 entries (4K bytes); values less than 8h are reserved. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td>2^{EventLen} entries (2^{EventLen}*16 bytes).</td></tr> </table>	Bits	Description	7h-0h	Reserved.	Fh-8h	2 ^{EventLen} entries (2 ^{EventLen} *16 bytes).
Bits	Description						
7h-0h	Reserved.						
Fh-8h	2 ^{EventLen} entries (2 ^{EventLen} *16 bytes).						
23:20	Reserved.						
19:0	EventBase[51:32]: event log base address bits [51:32] . See: IOMMUx10[EventBase[31:12]].						

IOMMUx18 Control Low

Bits	Description
31:30	Reserved.
29	GaIntEn . Read-write. Reset: 0.
28	GaLogEn . Read-write. Reset: 0.
27:25	GamEn . Read-write. Reset: 0.
24	SmiFLogEn: SMI filter log enable . Read-write. Reset: 0. Specifies if blocked SMI interrupts are reported in the IOMMU event log. When SmiFSup=00b, SmiFLogEn is ignored by hardware and may be implemented as a read-only value of 0b. 0b=SMI interrupts are not logged in the IOMMU event log (same behavior as IOMMU Revision 1). 1b=SMI interrupts blocked due to a match-failure with all valid (SmiDV=1b) SMI filter registers are reported in the IOMMU event log.
23	GaP2pWriteDis . Read-write. Reset: 0.
22	SmiFEn: SMI filter enable . Read-write. Reset: 0. Specifies how SMI interrupts are controlled by the IOMMU. When SmiFSup=00b, SmiFEn is ignored by hardware and may be implemented as a read-only value of 0b. 0b=SMI interrupts are always passed-through (same behavior as IOMMU Revision 1). 1b=SMI interrupts are blocked unless otherwise controlled by the SMI Filter Registers and blocked SMI interrupts are reported in the event log as governed by SmiFLogEn.

21:18	Tlpt. Read-write. Reset: 0. Tlpt contains the 4-bit value matched to the PCIe TLP Type field when the PCIe TLP Fmt value indicates the field carries a prefix.
17	GaEn. Read-write. Reset: 0. Guest APIC enable. 1 = loose. 0 = prohibited
16	GtEn. Read-write. Reset: 0. 1=Guest translation may be enabled for a peripheral by programming DTE[GV]. This bit must be programmed to zero when IOMMUx30[GtSup] =0.
15	PprEn. Read-write. Reset: 0. 1=Peripheral page service requests are processed. 0=Peripheral page service requests are treated as invalid device requests. This bit must be programmed to zero when IOMMUx30[PprSup] =0.
14	PprIntEn. Read-write. Reset: 0. 1=An interrupt is generated when IOMMUx2020[PprInt] =1 or IOMMUx2020[PprOverflow] =1. The interrupt vector used is indicated in D0F2x50[IommuM-siNumPpr] . This bit must be programmed to zero when IOMMUx30[PprSup] =0.
13	PprLogEn. Read-write. Reset: 0. 1=Peripheral page service request events are written to the peripheral page service request log when IommuEn=1. 0=Peripheral page service request logging is not enabled. Peripheral page service requests are discarded when PprLogEn=0 or IOMMUx30[PprSup] =0. When IommuEn=1 and software sets PprLogEn, the IOMMU clears IOMMUx2020[PprOverflow] and sets IOMMUx2020[PprRun] . The IOMMU can then write new entries to the event log if there are usable entries available. Software can read IOMMUx2020[PprRun] to determine the status of the peripheral page service request log. Note the peripheral page service request and event logs are independent. IOMMUx38 , IOMMUx2030 , and IOMMUx2038 must be programmed prior to setting PprLogEn.
12	CmdBufEn. Read-write. Reset: 0. 1=Start or restart command buffer processing. When CmdBufEn=1 and IommuEn=1, the IOMMU starts fetching commands and sets IOMMUx2020[CmdBufRun] . 0=Halt command buffer processing. Writing a 0 to this bit causes the IOMMU to cease fetching new commands although commands previously fetched are completed. The IOMMU stops fetching commands upon reset and after errors. See IOMMUx2020[CmdBufRun] . Writing of event log entries is independently controlled by EventLogEn. IOMMUx08 , IOMMUx0C , IOMMUx2000 , and IOMMUx2008 must be programmed prior to setting CmdBufEn.
11	Isoc. Read-write. Reset: 0. This bit controls the state of the isochronous bit in the HyperTransport read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link. 1=Request packet to use isochronous channel. 0=Request packet to use standard channel. If IOMMU isoc requests are enabled, then we must ensure the isoc channel is enabled as well. See D0F0x98_x1E[HiPriEn] .
10	Coherent. Read-write. Reset: 1. This bit controls the state of the coherent bit in the HyperTransport read request packet when the IOMMU issues device table reads on the HyperTransport link. 1=Device table requests are snooped by the processor. 0=Device table requests are not snooped by the processor.
9	ResPassPw. Read-write. Reset: 0. This bit controls the state of the ResPassPW bit in the HyperTransport read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link. 1=Response may pass posted requests. 0=Response may not pass posted requests.
8	PassPw. Read-write. Reset: 0. This bit controls the state of the PassPW bit in the HyperTransport read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link. 1=Request packet may pass posted requests. 0=Request packet may not pass posted requests.

7:5	InvTimeout. Read-write. Reset: 0. This field specifies the invalidation timeout for IOTLB invalidation requests. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>No timeout.</td></tr> <tr> <td>001b</td><td>1 ms.</td></tr> <tr> <td>010b</td><td>10 ms.</td></tr> <tr> <td>011b</td><td>100 ms.</td></tr> <tr> <td>100b</td><td>1 sec.</td></tr> <tr> <td>101b</td><td>10 sec.</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	No timeout.	001b	1 ms.	010b	10 ms.	011b	100 ms.	100b	1 sec.	101b	10 sec.	111b-110b	Reserved
Bits	Description																
000b	No timeout.																
001b	1 ms.																
010b	10 ms.																
011b	100 ms.																
100b	1 sec.																
101b	10 sec.																
111b-110b	Reserved																
4	ComWaitIntEn. Read-write. Reset: 0. 1=An interrupt is generated when IOMMUx200[ComWaitInt] =1.																
3	EventIntEn. Read-write. Reset: 0. 1=An interrupt is generated when IOMMUx200[EventLogInt] =1 or IOMMUx200[EventOverflow] =1.																
2	EventLogEn. Read-write. Reset: 0. 1=All events detected are written to the event log when IommuEn =1. 0=Event logging is not enabled. Events are discarded when the event log is not enabled. When IommuEn =1 and software sets EventLogEn , the IOMMU clears IOMMUx200[EventOverflow] and sets IOMMUx200[EventLogRun] . IOMMUx10 , IOMMUx14 , IOMMUx2010 , and IOMMUx2018 must be programmed prior to setting EventLogEn .																
1	HtTunEn. Read-write. Reset: 0. 1= Upstream traffic received by the HyperTransport tunnel is translated by the IOMMU. 0=Upstream traffic received by the HyperTransport tunnel is not translated by the IOMMU. The IOMMU ignores the state of this bit while IommuEn =0. See D0F2x40[IommuHtTunnelSup] .																
0	IommuEn. Read-write. Reset: 0. 1=IOMMU enabled. All upstream transactions are translated by the IOMMU. IOMMUx00 [Device Table Base Address Low] and IOMMUx04 [Device Table Base Address High] must be configured by software before setting this bit. 0=IOMMU is disabled and no upstream transactions are translated or remapped by the IOMMU. When disabled, the IOMMU does not read any commands or create any event log entries.																

IOMMUx20 Exclusion Range Base Low

Bits	Description
31:12	ExclBase[31:12]: exclusion range base address bits[31:12]. Read-write. Reset: 0. ExclBase[51:12] = { IOMMUx20[ExclBase[51:32]] , ExclBase[31:12] }. Specifies the 4Kbyte-aligned base address of the exclusion range.
11:2	Reserved.
1	ExAllow: exclusion allow. Read-write. Reset: 0. 1=All accesses to the exclusion range are forwarded untranslated. 0=The EX bit in the device table entry specifies if accesses to the exclusion range are translated.
0	ExEn: exclusion enable. Read-write. Reset: 0. 1=The exclusion range is enabled.

IOMMUx24 Exclusion Range Base High

Bits	Description
------	-------------

31:20	Reserved.
19:0	ExclBase[51:32]: exclusion range base address bits[51:32]. See: IOMMUx20[ExclBase[31:12]] .

IOMMUx28 Exclusion Range Limit Low

Bits	Description
31:12	ExclLimit[31:12]: exclusion range limit address bits[31:12]. Read-write. Reset: 0. ExclLimit[51:12] = { IOMMUx2C[ExclLimit[51:32]] , ExclLimit[31:12]}. ExclLimit[51:12] specifies the 4Kbyte-aligned limit address of the exclusion range.
11:0	Reserved.

IOMMUx2C Exclusion Range Limit High

Bits	Description
31:20	Reserved.
19:0	ExclLimitHi. See: IOMMUx28[ExclLimit[31:12]] .

IOMMUx30 Extended Feature Low

Bits	Description														
31:30	Reserved.														
29:28	Reserved.														
27:26	Reserved.														
25:24	Reserved.														
23:21	GamSup: General AVIC Mode Supported. Read-only. Reset:0. Indicates the AVIC mode supported. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Interrupt Remapping Only. No AVIC supported</td></tr> <tr> <td>001b</td><td>AVIC supported</td></tr> <tr> <td>111b-010b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	Interrupt Remapping Only. No AVIC supported	001b	AVIC supported	111b-010b	Reserved						
Bits	Description														
000b	Interrupt Remapping Only. No AVIC supported														
001b	AVIC supported														
111b-010b	Reserved														
20:18	SmiFRC: SMI-Filter Register Count. Read-only. Reset: 2. Indicates the number of SMI interrupt filter registers. SmiFRC must be 000b when SmiFSup=00b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>1 SMI filter registers</td></tr> <tr> <td>001b</td><td>2 SMI filter registers</td></tr> <tr> <td>010b</td><td>4 SMI filter registers</td></tr> <tr> <td>011b</td><td>8 SMI filter registers</td></tr> <tr> <td>100b</td><td>16 SMI filter registers</td></tr> <tr> <td>111b-101b</td><td>Reserved</td></tr> </table>	Bits	Description	000b	1 SMI filter registers	001b	2 SMI filter registers	010b	4 SMI filter registers	011b	8 SMI filter registers	100b	16 SMI filter registers	111b-101b	Reserved
Bits	Description														
000b	1 SMI filter registers														
001b	2 SMI filter registers														
010b	4 SMI filter registers														
011b	8 SMI filter registers														
100b	16 SMI filter registers														
111b-101b	Reserved														

17:16	SmiFSup: SMI Filter Supported. Read-only. Reset: 1. Specifies that SMI interrupts may be filtered. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>SMI interrupts are always passed-through.</td></tr> <tr> <td>01b</td><td>SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers.</td></tr> <tr> <td>11b-10b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	SMI interrupts are always passed-through.	01b	SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers.	11b-10b	Reserved		
<u>Bits</u>	<u>Description</u>										
00b	SMI interrupts are always passed-through.										
01b	SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers.										
11b-10b	Reserved										
15:14	GlxFSup. Read-only. Reset: 1. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0.</td></tr> <tr> <td>01b</td><td>Two-level GCR3 base address table is supported in hardware.</td></tr> <tr> <td>10b</td><td>Three-level GCR3 base address table is supported in hardware for 20-bit PASID values.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0.	01b	Two-level GCR3 base address table is supported in hardware.	10b	Three-level GCR3 base address table is supported in hardware for 20-bit PASID values.	11b	Reserved.
<u>Bits</u>	<u>Description</u>										
00b	GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0.										
01b	Two-level GCR3 base address table is supported in hardware.										
10b	Three-level GCR3 base address table is supported in hardware for 20-bit PASID values.										
11b	Reserved.										
13:12	Reserved.										
11:10	HATS: host address translation size. Read-only. Reset: 2. The maximum number of host address translation levels supported. This value is not meaningful when GtSup=0. IOMMU behaviour is undefined if Next Level in a page directory entry exceeds the limit set by HATS. See D0F2x80[HatsW] . <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>4 levels.</td></tr> <tr> <td>01b</td><td>5 levels.</td></tr> <tr> <td>10b</td><td>6 levels.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	<u>Bits</u>	<u>Description</u>	00b	4 levels.	01b	5 levels.	10b	6 levels.	11b	Reserved.
<u>Bits</u>	<u>Description</u>										
00b	4 levels.										
01b	5 levels.										
10b	6 levels.										
11b	Reserved.										
9	PcSup: performance counters supported. Read-only. Reset: 1. 1=performance counters are supported.										
8	HeSup: hardware error registers supported. Read-only. Reset: 0. 0=Hardware error registers do not report error information. 1=Error information is reported in hardware error registers.										
7	GaSup: guest APIC supported. Read-only. Reset: 0. 1=Guest APIC supported.										
6	IaSup: INVALIDATE_IOMMU_ALL supported. Read-only. Reset: 1. 1=The INVALIDATE_IOMMU_ALL command is supported.										
5	Reserved.										
4	GtSup: guest translation supported. Read-only. Reset: 1. 1=Guest address translation is supported. 0=Only nested address translation is supported. When GtSup=0, the following values in the DTE must be zero: GV, GLX and GCR3 Table Root Pointer. See IOMMUx18[GtEn] .										
3	NxSup: no execute supported. Read-only. Reset: 0. 1=No-execute protection is supported. 0=No-execute protection is not supported.										
2	XtSup: x2 apic supported. Read-only. Reset: 0. 1=The interrupt remapping table is expanded to support x2APIC interrupt information. 0=x2APIC support is disabled.										
1	PprSup: peripheral page service request supported. Read-only. Reset: 1. 1=Indicates that IOMMU handles page service request events from peripherals, the IOMMU supports the page service request queue, and that the second IOMMU interrupt can be used to signal peripheral page service request events.										
0	PrefSup: prefetch support. Read-only. Reset: 1. 1=Indicates that IOMMU will accept PREFETCH_IOMMU_PAGES commands.										

IOMMUx34 Extended Feature High

Bits	Description						
31:4	Reserved.						
3:0	<p>PasMax: PASID maximum. Read-only. Reset: 8h. This specifies the maximum PASID value supported. This field is not meaningful when IOMMUx30[GtSup]=0. See D0F2x84[PasMaxW].</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>2h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-3h</td><td>$2^{(\text{PasMax}+1)}-1$.</td></tr> </table>	Bits	Description	2h-0h	Reserved.	Fh-3h	$2^{(\text{PasMax}+1)}-1$.
Bits	Description						
2h-0h	Reserved.						
Fh-3h	$2^{(\text{PasMax}+1)}-1$.						

IOMMUx38 PPR Log Base Address Low

Bits	Description
31:12	PprBase[31:12]: ppr base address bits[31:12]. Read-write. Reset: 0. $\text{PprBase}[51:12] = \{\text{IOMMUx3C}[\text{PprBase}[51:32]], \text{PprBase}[31:12]\}$. $\text{PprBase}[51:12]$ specifies the 4Kbyte-aligned base address of the PPR log.
11:0	Reserved.

IOMMUx3C PPR Log Base Address High

Bits	Description						
31:28	Reserved.						
27:24	<p>PprLen: ppr length. Read-write. Reset: 8h. Specifies the length of the PPR log in power of two increments.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td>2^{PprLen} entries ($2^{\text{PprLen}} \times 16$ bytes).</td></tr> </table>	Bits	Description	7h-0h	Reserved.	Fh-8h	2^{PprLen} entries ($2^{\text{PprLen}} \times 16$ bytes).
Bits	Description						
7h-0h	Reserved.						
Fh-8h	2^{PprLen} entries ($2^{\text{PprLen}} \times 16$ bytes).						
23:20	Reserved.						
19:0	PprBase[51:32]: ppr base address bits[51:32]. See: IOMMUx38 [31:12].						

IOMMUx40 Hardware Error Upper Low

Bits	Description
31:0	FirstEvCode[31:0]: first event code bits[31:0]. Read-write. Reset: 0. $\text{FirstEvCode}[59:0] = \{\text{IOMMUx44}[\text{FirstEvCode}[59:32]], \text{FirstEvCode}[31:0]\}$. IOMMUx44 [EvCode] and $\text{FirstEvCode}[59:0]$ specify the upper 64 bits of the most recent hardware error detected by the IOMMU.

IOMMUx44 Hardware Error Upper High

Bits	Description
------	-------------

31:28	EvCode: event code. Read-write. Reset: 0. Event code for the type of error logged.
27:0	FirstEvCode[59:32]: first event code bits[59:32]. See: IOMMUx40 [FirstEvCode[31:0]].

IOMMUx48 Hardware Error Lower Low

Bits	Description
31:0	SecondEvCode[31:0]: second event code bits[31:0]. Read-write. Reset: 0. SecondEvCode[63:0] = { IOMMUx4C [SecondEvCode[63:32]], SecondEvCode[31:0]}. SecondEvCode[63:0] specifies the lower 64 bits of the most recent hardware error detected by IOMMU.

IOMMUx4C Hardware Error Lower High

Bits	Description
31:0	SecondEvCode[63:32]: second event code bits[63:32]. See: IOMMUx48 [SecondEvCode[31:0]].

IOMMUx50 Hardware Error Status

Bits	Description
31:2	Reserved.
1	HEO: hardware error overflow. Read-write. Reset: 0. Defines the contents of the IOMMU hardware error registers as having been overwritten. 0=not overwritten. 1=contents overwritten by new information. HEO is only valid when HEV==1.
0	HEV: hardware error valid. Read-write. Reset: 0. 1=Contents of the IOMMU hardware error registers are valid.

IOMMUx[78,70,68,60] SMI Filter Low

Table 190: [Register Mapping](#) for [IOMMUx\[78,70,68,60\]](#)

Register	Function
IOMMUx60	SMI Filter 0
IOMMUx68	SMI Filter 1
IOMMUx70	SMI Filter 2
IOMMUx78	SMI Filter 3

Bits	Description
31:18	Reserved.
17	SMIFlock: SMI Filter Lock. Read-write. Reset: 0.
16	SMIDV: SMI Device Valid. IF (SMIFlock==1) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. The SMI filter is enabled and the device ID specified in SmiDID is valid for SMI.
15:0	SMIDid: SMI Device ID. IF (SMIFlock==1) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Specifies the device ID for which SMIs are forwarded upstream.

IOMMUx[7C,74,6C,64] SMI Filter HighTable 191: [Register Mapping](#) for IOMMUx[7C,74,6C,64]

Register	Function
IOMMUx64	SMI Filter 0
IOMMUx6C	SMI Filter 1
IOMMUx74	SMI Filter 2
IOMMUx7C	SMI Filter 3

Bits	Description
31:0	Reserved.

IOMMUxE0 Guest APIC Log Base Address Low

Bits	Description
31:12	GaLogBase[31:12]: guest APIC log base address bits[31:12]. Read-write. Reset: 0. GaLogBase[51:12] = { IOMMUxE4 [GaLogBase[51:32], GaLogBase[31:12]]}. GaLogBase[51:12] specifies the 4Kbyte-aligned base address of the guest virtual APIC log.
11:0	Reserved.

IOMMUxE4 Guest APIC Log Base Address High

Bits	Description
31:28	Reserved.
27:24	GaLogLen: guest APIC log length. Read-write. Reset: 8h. Indicates the length of the guest virtual APIC log.
23:20	Reserved.
19:0	GaLogBase[51:32]: guest APIC log base address bit[51:32]. See: IOMMUxE0 [GaLogBase[31:12]].

IOMMUxE8 Guest APIC Log Tail Address Low

Bits	Description
31:3	GaTAddr[31:3]: guest APIC log tail address[31:12]. Read-write. Reset: 0.
2:0	Reserved.

IOMMUxEC Guest APIC Log Tail Address High

Bits	Description
31:20	Reserved.
19:0	GaTAddr[51:32]: guest APIC log tail address [51:32]. See: IOMMUxE8 [GaTAddr[31:3]].

IOMMUx1FF8 P2P Data

Bits	Description
31:0	P2pData . Read-write. Reset: 0.

IOMMUx2000 Command Buffer Head Pointer

Bits	Description
31:19	Reserved.
18:4	CmdHdptr: command buffer head pointer . Read-write; updated-by-hardware. Reset: 0. Specifies the 128-bit aligned offset from the command buffer base address register of the next command to be fetched by the IOMMU. The IOMMU increments this register, rolling over to zero at the end of the buffer, after fetching and validating the command in the command buffer. After incrementing this register, the IOMMU cannot re-fetch the command from the buffer. If this register is written by software while IOMMUx2020[CmdBufRun]=1 , the IOMMU behavior is undefined. If this register is set by software to a value outside the length specified by IOMMUx0C[ComLen] , the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2008 Command Buffer Tail Pointer

Bits	Description
31:19	Reserved.
18:4	CmdTailptr: command buffer tail pointer . Read-write; updated-by-hardware. Reset: 0. Specifies the 128-bit aligned offset from the command buffer base address register of the next command to be written by the software. Software must increment this field, rolling over to zero at the end of the buffer, after writing a command to the command buffer. If software advances the tail pointer equal to or beyond the head pointer after adding one or more commands to the buffer, the IOMMU behavior is undefined. If software sets the command buffer tail pointer to an offset beyond the length of the command buffer, the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2010 Event Log Head Pointer

Bits	Description
31:19	Reserved.
18:4	EventHdptr: event log head pointer . Read-write. Reset: 0. Specifies the 128 bit aligned offset from the event log base address register that will be read next by software. Software must increment this field, rolling over at the end of the buffer, after reading an event from the event log. If software advances the head pointer beyond the tail pointer, the IOMMU behavior is undefined. If software sets the event log head pointer to an offset beyond the length of the event log, the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2018 Event Log Tail Pointer

Bits	Description
31:19	Reserved.
18:4	EventTailptr: event log tail pointer. Read-write. Reset: 0. Specifies the 128-bit aligned offset from the event log base address register that will be written next by the IOMMU when an event is detected. The IOMMU increments this register, rolling over at the end of the buffer, after writing an event to the event log. If this register is written while IOMMUx2020[EventLogRun]=1 , the IOMMU behavior is undefined. If this register is set by software to a value outside the length specified by IOMMUx14[EventLen] , the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2020 Status

Bits	Description
31:19	Reserved.
18	Reserved.
17	Reserved.
16	Reserved.
15	Reserved.
14:13	Reserved.
12	Reserved.
11	Reserved.
10	GaInt. Read-write; Write-1-to-clear. Reset: 0. 1 = GA request entry written to the GA log by the IOMMU. An interrupt is generated when this bit is set and IOMMUx18[GaIntEn]=1 . No new GA log entries are written when this bit is set.
9	GaOverflow. Read-write; Write-1-to-clear. Reset: 0. 1=IOMM GA log overflow has occurred. This bit is set when a new request is to be written to the GA log and there is no usable entry in the GA log, causing the new information to be discarded. No new GA log entries are written while this bit is set. See IOMMUx18[GaIntEn] .
8	GaRun. Read-only. Reset: 0. 1 = GA requests are logged as they occur. 0 = GA requests are discarded without logging. When IOMMUx2020[GaOverflow]=1 , IOMMU does not write new GA log entries even when this bit is set. When halted, GA request logging is restarted by using IOMMUx18[GaLogEn] .

7	PprRun: peripheral page service request running. Read-only. Reset: 0. 1=PPR requests are logged as they occur. 0=PPR requests are discarded without logging. When PprOverflow=1, the IOMMU does not write new PPR log entries even when PprRun=1. When halted, PPR request logging is restarted by using IOMMUx18[PprLogEn] .
6	PprInt: peripheral page service request interrupt. Read-write; Write-1-to-clear. Reset: 0. 1=PPR request entry written to the PPR log by the IOMMU. 0=No PPR entry written to the PPR log by the IOMMU. See IOMMUx18[PprIntEn] .
5	PprOverflow: peripheral page service request overflow. Read-write; Write-1-to-clear. Reset: 0. 1=IOMMU PPR log overflow has occurred. This bit is set when a new peripheral page service request is to be written to the PPR log and there is no usable entry in the PPR log, causing the new information to be discarded. No new PPR log entries are written while this bit is set. See IOMMUx18[PprIntEn] .
4	CmdBufRun: command buffer running. Read-only. Reset: 0. 1=Commands may be fetched from the command buffer. 0=IOMMU has stopped fetching new commands. The IOMMU freezes command processing after <code>COMMAND_HARDWARE_ERROR</code> or <code>ILLEGAL_COMMAND_ERROR</code> errors. When frozen, command fetching is restarted by using IOMMUx18[CmdBufEn] .
3	EventLogRun: event log running. Read-only. Reset: 0. 1=Events are logged as they occur. 0=Event reports are discarded without logging. When EventOverflow=1, the IOMMU does not write new event log entries even when EventLogRun=1. When halted, event logging is restarted by using IOMMUx18[EventLogEn] .
2	ComWaitInt: completion wait interrupt. Read-write; Write-1-to-clear. Reset: 0. 1=COMPLETION_WAIT command completed. This bit is only set if the i bit is set in the COMPLETION_WAIT command. See IOMMUx18[ComWaitIntEn] .
1	EventLogInt: event log interrupt. Read-write; Write-1-to-clear. Reset: 0. 1=Event entry written to the event log by the IOMMU. See IOMMUx18[EventIntEn] .
0	EventOverflow. Read-write; Write-1-to-clear. Reset: 0. 1=IOMMU event log overflow has occurred. This bit is set when a new event is to be written to the event log and there is no usable entry in the event log, causing the new event information to be discarded. No new event log entries are written while this bit is set. See IOMMUx18[EventIntEn] .

IOMMUx2030 PPR Log Head Pointer

Bits	Description
31:19	Reserved.
18:4	PprHdptr: ppr head pointer. Read-write. Reset: 0. Specifies the 128-bit aligned offset from the PPR log base address register that will be read next by software. Software must increment this field, rolling over at the end of the buffer, after reading a PPR request entry from the PPR event log. If software advances the head pointer beyond the tail pointer, the IOMMU behavior is undefined. If software sets the PPR log head pointer to an offset beyond the length of the PPR log, the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2038 PPR Log Tail Pointer

Bits	Description
31:19	Reserved.
18:4	PprTailptr. Read-write. Reset: 0. Specifies the 128-bit aligned offset from the PPR log base address register that will be written next by the IOMMU when a PPR request is detected. The IOMMU increments this register, rolling over at the end of the buffer, after writing a PPR request to the PPR log. If this register is written while IOMMUx2020[PprRun]=1 , the IOMMU behavior is undefined. If software sets the PPR log tail pointer to an offset beyond the length of the PPR log, defined by IOMMUx3C[PprLen] , the IOMMU behavior is undefined.
3:0	Reserved.

IOMMUx2040 Guest APIC Log Head Pointe Low

Bits	Description
31:16	Reserved.
15:3	GaHdptr. Read-write. Reset: 0.
2:0	Reserved.

IOMMUx2048 Guest APIC Log Tail Pointer Low

Bits	Description
31:16	Reserved.
15:3	GaTailptr. Read-write. Reset: 0.
2:0	Reserved.

IOMMUx4000 Counter Configuration

Bits	Description						
31:18	Reserved.						
17:12	NCounterBanks: number of counter banks. Read-only. Reset: 2h. The number of counter banks supported by the IOMMU. Each bank contains two or more counter and control registers as specified by NCounter. For each counter bank, a corresponding control bit is in IOMMUx4008 , IOMMUx4010 , and IOMMUx4018 . Each supported event counter bank is in a distinct, consecutive 4K byte page. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>No counter banks supported.</td></tr> <tr> <td>3Fh-01h</td><td>NCounterBanks event counter banks are supported.</td></tr> </table> Note: IOMMU event counter banks are numbered starting with 0.	Bits	Description	00h	No counter banks supported.	3Fh-01h	NCounterBanks event counter banks are supported.
Bits	Description						
00h	No counter banks supported.						
3Fh-01h	NCounterBanks event counter banks are supported.						
11	Reserved.						

10:7	NCounter: number of counters per bank. Read-only. Reset: 4h. Reports the number of individual counters in each IOMMU counter bank. Each counter bank contains the same number of counters. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No counters supported.</td></tr> <tr> <td>1h</td><td>Reserved.</td></tr> <tr> <td>Fh-2h</td><td>NCounter counters in each bank.</td></tr> </table>	Bits	Description	0h	No counters supported.	1h	Reserved.	Fh-2h	NCounter counters in each bank.
Bits	Description								
0h	No counters supported.								
1h	Reserved.								
Fh-2h	NCounter counters in each bank.								
6:0	Reserved.								

IOMMUx4008 Counter PASID Bank Lock Low

Bits	Description
31:0	PasidLock[31:0]: pasid lock enable bits[31:0]. Read-write. Reset: 0. PasidLock[63:0] = { IOMMUx400C [PasidLock[63:32]], PasidLock[31:0]}. For each bit in PasidLock[63:0], if the bit is set then writes to the corresponding bank in IOMMUx4[1,0][3:0]10 and IOMMUx4[1,0][3:0]14 are ignored. Bit positions above the value reported in IOMMUx4000 [NCounterBanks] are ignored when written and return zero when read.

IOMMUx400C Counter PASID Bank Lock High

Bits	Description
31:0	PasidLock[63:32]. See: IOMMUx4008 [PasidLock[31:0]].

IOMMUx4010 Domain Bank Lock Low

Bits	Description
31:0	DomainLock[31:0]: domain lock enable bits[31:0]. Read-write. Reset: 0. DomainLock[63:0] = { IOMMUx4014 [DomainLock[63:32]], DomainLock[31:0]}. For each bit in DomainLock[63:0], if the bit is set then writes to the corresponding bank in IOMMUx4[1,0][3:0]18 and IOMMUx4[1,0][3:0]1C are ignored. Bit positions above the value reported in IOMMUx4000 [NCounterBanks] are ignored when written and return zero when read.

IOMMUx4014 Domain Bank Lock High

Bits	Description
31:0	DomainLock[63:32]. See: IOMMUx4010 [DomainLock[31:0]].

IOMMUx4018 DeviceID Bank Lock Low

Bits	Description
31:0	DevIDLock[31:0]: deviceID lock enable bits[31:0]. Read-write. Reset: 0. DevIDLock[63:0] = { IOMMUx401C [DevIDLock[63:32]], DevIDLock[31:0]}. For each bit in DevIDLock[63:0], if the bit is set then writes to the corresponding bank in IOMMUx4[1,0][3:0]20 and IOMMUx4[1,0][3:0]24 are ignored. Bit positions above the value reported in IOMMUx4000 [NCounterBanks] are ignored when written and return zero when read.

IOMMUx401C DeviceID Bank Lock High

Bits	Description
31:0	DevIDLock[63:32] . See: IOMMUx4018 [DevIDLock[31:0]].

IOMMUx4[1,0][3:0]00 Counter LowTable 192: [Register Mapping](#) for IOMMUx4[1,0][3:0]00

Register	Function	Register	Function
IOMMUx40000	Bank 0 Counter 0	IOMMUx41000	Bank 1 Counter 0
IOMMUx40100	Bank 0 Counter 1	IOMMUx41100	Bank 1 Counter 1
IOMMUx40200	Bank 0 Counter 2	IOMMUx41200	Bank 1 Counter 2
IOMMUx40300	Bank 0 Counter 3	IOMMUx41300	Bank 1 Counter 3

Bits	Description
31:0	Icounter[31:0] . Read-write. Reset: 0. Icounter[47:0] = { IOMMUx4[1,0][3:0]04 [Icounter[47:32]], Icounter[31:0]}. Icounter[47:0] reports the counter value. The counter counts up continuously, wrapping at the maximum value. There is no overflow indicator.

IOMMUx4[1,0][3:0]04 Counter HighTable 193: [Register Mapping](#) for IOMMUx4[1,0][3:0]04

Register	Function	Register	Function
IOMMUx40004	Bank 0 Counter 0	IOMMUx41004	Bank 1 Counter 0
IOMMUx40104	Bank 0 Counter 1	IOMMUx41104	Bank 1 Counter 1
IOMMUx40204	Bank 0 Counter 2	IOMMUx41204	Bank 1 Counter 2
IOMMUx40304	Bank 0 Counter 3	IOMMUx41304	Bank 1 Counter 3

Bits	Description
31:16	Reserved.
15:0	Icounter[47:32] . See: IOMMUx4[1,0][3:0]00 [Icounter[31:0]].

IOMMUx4[1,0][3:0]08 Counter SourceTable 194: [Register Mapping](#) for IOMMUx4[1,0][3:0]08

Register	Function	Register	Function
IOMMUx40008	Bank 0 Counter 0	IOMMUx41008	Bank 1 Counter 0
IOMMUx40108	Bank 0 Counter 1	IOMMUx41108	Bank 1 Counter 1
IOMMUx40208	Bank 0 Counter 2	IOMMUx41208	Bank 1 Counter 2
IOMMUx40308	Bank 0 Counter 3	IOMMUx41308	Bank 1 Counter 3

Bits	Description
31	Cac: counter source architectural or custom. Read-write. Reset: 0. 0=Architectural counter input group. 1=Custom input group.
30	CountUnits. Read-write. Reset: 0. 0=Counter counts events (level). 1=Counter counts clocks (edges).
29:8	Reserved.
7:0	Csource: counter source. Read-write. Reset: 0. Counter source. Selects event counter input from the choices provided.

IOMMUx4[1,0][3:0]10 PASID Match Low

See [IOMMUx4008](#).

Table 195: [Register Mapping](#) for IOMMUx4[1,0][3:0]10

Register	Function	Register	Function
IOMMUx40010	Bank 0 Counter 0	IOMMUx41010	Bank 1 Counter 0
IOMMUx40110	Bank 0 Counter 1	IOMMUx41110	Bank 1 Counter 1
IOMMUx40210	Bank 0 Counter 2	IOMMUx41210	Bank 1 Counter 2
IOMMUx40310	Bank 0 Counter 3	IOMMUx41310	Bank 1 Counter 3

Bits	Description
31	PasMEN: PASID match enable. Read-write. Reset: 0. 0=PASID is ignored. 1=Filtered PASID must match to count an event. An event with no PASID tag is only counted when Pasmem=0.
30:16	Reserved.
15:0	PasidMatch. Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming PASID of the transaction to decide if the corresponding event is counted. The event is counted if PasidMatch is exactly equal to the masked incoming PASID.

IOMMUx4[1,0][3:0]14 PASID Match High

See [IOMMUx4008](#).

Table 196: [Register Mapping](#) for IOMMUx4[1,0][3:0]14

Register	Function	Register	Function
IOMMUx40014	Bank 0 Counter 0	IOMMUx41014	Bank 1 Counter 0
IOMMUx40114	Bank 0 Counter 1	IOMMUx41114	Bank 1 Counter 1
IOMMUx40214	Bank 0 Counter 2	IOMMUx41214	Bank 1 Counter 2
IOMMUx40314	Bank 0 Counter 3	IOMMUx41314	Bank 1 Counter 3

Bits	Description
31:16	Reserved.
15:0	PasidMask. Read-write. Reset: 0. This bit-mask is ANDed with the PASID of the transaction to decide to count the corresponding event. 0=Count events for all values of incoming PASID. 0001h-FFFFh=Bit-wise mask ANDed with incoming PASID.

IOMMUx4[1,0][3:0]18 Domain Match Low

Table 197: Register Mapping for IOMMUx4[1,0][3:0]18

Register	Function	Register	Function
IOMMUx40018	Bank 0 Counter 0	IOMMUx41018	Bank 1 Counter 0
IOMMUx40118	Bank 0 Counter 1	IOMMUx41118	Bank 1 Counter 1
IOMMUx40218	Bank 0 Counter 2	IOMMUx41218	Bank 1 Counter 2
IOMMUx40318	Bank 0 Counter 3	IOMMUx41318	Bank 1 Counter 3

Bits	Description
31	DomMEN: domain match enable. Read-write. Reset: 0. 0=Domain is ignored. 1=Filtered Domain must match DomainMatch to count an event.
30:16	Reserved.
15:0	DomainMatch. Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming Domain of the transaction to decide to count the corresponding event. The event is counted if DomainMatch is exactly equal to the masked incoming Domain.

IOMMUx4[1,0][3:0]1C Domain Match High

Table 198: Register Mapping for IOMMUx4[1,0][3:0]1C

Register	Function	Register	Function
IOMMUx4001C	Bank 0 Counter 0	IOMMUx4101C	Bank 1 Counter 0
IOMMUx4011C	Bank 0 Counter 1	IOMMUx4111C	Bank 1 Counter 1
IOMMUx4021C	Bank 0 Counter 2	IOMMUx4121C	Bank 1 Counter 2
IOMMUx4031C	Bank 0 Counter 3	IOMMUx4131C	Bank 1 Counter 3

Bits	Description
31:16	Reserved.
15:0	DomainMask. Read-write. Reset: 0. This bit-mask is ANDed with the Domain of the transaction to decide to count the corresponding event. 0000h=Count events for all values of incoming Domain. 0001h-FFFFh=Bit-wise mask ANDed with incoming Domain.

IOMMUx4[1,0][3:0]20 DeviceID Match Low

Table 199: Register Mapping for IOMMUx4[1,0][3:0]20

Register	Function	Register	Function
IOMMUx40020	Bank 0 Counter 0	IOMMUx41020	Bank 1 Counter 0
IOMMUx40120	Bank 0 Counter 1	IOMMUx41120	Bank 1 Counter 1
IOMMUx40220	Bank 0 Counter 2	IOMMUx41220	Bank 1 Counter 2
IOMMUx40320	Bank 0 Counter 3	IOMMUx41320	Bank 1 Counter 3

Bits	Description
31	DidMEN: deviceID match enable. Read-write. Reset: 0. 0=DeviceID is ignored. 1=Filtered DeviceID must match to count an event.
30:16	Reserved.
15:0	DeviceidMatch. Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming DeviceID of the transaction to decide to count the corresponding event. The event is counted if DeviceidMatch is exactly equal to the masked incoming DeviceID.

IOMMUx4[1,0][3:0]24 DeviceID Match High

Table 200: [Register Mapping](#) for IOMMUx4[1,0][3:0]24

Register	Function	Register	Function
IOMMUx40024	Bank 0 Counter 0	IOMMUx41024	Bank 1 Counter 0
IOMMUx40124	Bank 0 Counter 1	IOMMUx41124	Bank 1 Counter 1
IOMMUx40224	Bank 0 Counter 2	IOMMUx41224	Bank 1 Counter 2
IOMMUx40324	Bank 0 Counter 3	IOMMUx41324	Bank 1 Counter 3

Bits	Description
31:16	Reserved.
15:0	DeviceidMask. Read-write. Reset: 0. This bit-mask is ANDed with the DeviceID of the transaction to decide to count the corresponding event. 0=Count events for all values of incoming DeviceID. 0001h-FFFFh= Bit-wise mask ANDed with incoming DeviceID.

IOMMUx4[1,0][3:0]28 Counter Report Low

Table 201: [Register Mapping](#) for IOMMUx4[1,0][3:0]28

Register	Function	Register	Function
IOMMUx40028	Bank 0 Counter 0	IOMMUx41028	Bank 1 Counter 0
IOMMUx40128	Bank 0 Counter 1	IOMMUx41128	Bank 1 Counter 1
IOMMUx40228	Bank 0 Counter 2	IOMMUx41228	Bank 1 Counter 2
IOMMUx40328	Bank 0 Counter 3	IOMMUx41328	Bank 1 Counter 3

Bits	Description
31:0	EventNote[31:0]. Read-write. Reset: 0. EventNote[51:0] = {IOMMUx4[1,0][3:0]2C[Event-Note[51:32]], EventNote[31:0]}. When IOMMUx4[1,0][3:0]2C[CERE]=1 and the corresponding counter is incremented and wraps to zero, EventNote[51:0] is reported in the EVENT_COUNTER_ZERO event log entry.

IOMMUx4[1,0][3:0]2C Counter Report HighTable 202: [Register Mapping](#) for IOMMUx4[1,0][3:0]2C

Register	Function	Register	Function
IOMMUx4002C	Bank 0 Counter 0	IOMMUx4102C	Bank 1 Counter 0
IOMMUx4012C	Bank 0 Counter 1	IOMMUx4112C	Bank 1 Counter 1
IOMMUx4022C	Bank 0 Counter 2	IOMMUx4122C	Bank 1 Counter 2
IOMMUx4032C	Bank 0 Counter 3	IOMMUx4132C	Bank 1 Counter 3

Bits	Description
31	CERE: counter event report enable. Read-write. Reset: 0. Counter Event Report Enable. 0=no event report when counter wraps to zero. 1=IOMMU writes an EVENT_COUNTER_ZERO event log entry when the counter wraps to zero. The counter-wrap event is treated like any other event. Software note: the counter-wrap event is delivered promptly but without a latency assurance.
30:20	Reserved.
19:0	EventNote[51:32]. See: IOMMUx4[1,0][3:0]28 [EventNote[31:0]].

3.16 Northbridge IOAPIC Registers

The Northbridge IOAPIC is accessed through the Northbridge IOAPIC base address specified by [D0F0xFC_x01 \[IOAPIC Base Address Lower\]](#) and [D0F0xFC_x02 \[IOAPIC Base Address Upper\]](#).

NBIOAPICx00 IO Register Select

Bits	Description
31:8	Reserved.
7:0	IndirectAddressOffset . Read-write. Reset: 0. Specifies the indexed register accessed via NBIOAPICx10 [IO Window] .

NBIOAPICx10 IO Window

Bits	Description
31:0	IoapicData .

NBIOAPICx10_x00 IOAPIC ID

This register is not used in IOxAPIC PCI bus delivery mode.

Bits	Description
31:28	ExtendID: extended IOAPIC device ID . IF (D0F0xFC_x00 [IoapicIdExtEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.
27:24	ID: IOAPIC device ID . Read-write. Reset: 0.
23:0	Reserved.

NBIOAPICx10_x01 IOAPIC Version

Bits	Description
31:24	Reserved.
23:16	MaxRedirectionEntries . Value: 1Fh. Indicates 32 entries [31:0].
15	PRQ . Value: 1. IRQ pin assertion supported
14:8	Reserved.
7:0	Version . Value: 21h. PCI 2.2 compliant

NBIOAPICx10_x02 IOAPIC Arbitration

Bits	Description
31:28	Reserved.
27:24	ArbitrationID . Read-only. Reset: 0.
23:0	Reserved.

NBIOAPICx10_x[4E:10:step2] Redirection Table Entry [31:0]

Bits	Description																				
63:56	DestinationID. Read-write. Reset: 0. Bits [19:12] of the address field of the interrupt message.																				
55:32	Reserved.																				
31:17	Reserved.																				
16	Mask. Read-write. Reset: 1. 1=Mask the interrupt injection at the input of this device. 0=Unmask.																				
15	TriggerMode. Read-write. Reset: 0. 0=Edge. 1=Level																				
14	RemotelIRR. Read-only. Reset: 0. Used for level triggered interrupts only. It is cleared by EOI special cycle transaction or write to EOI register. 1=Interrupt message is delivered.																				
13	InterruptPinPolarity. Read-write. Reset: 0. 0=High. 1=Low.																				
12	DeliveryStatus. Read-only. Reset: 0. 0=Idle. 1=Send Pending.																				
11	DestinationMode. Read-write. Reset: 0. 0=Physical. 1=Logical																				
10:8	DeliveryMode. Read-write. Reset: 0. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>Fixed</td><td>100b</td><td>NMI</td></tr><tr><td>001b</td><td>Lowest Priority</td><td>101b</td><td>INIT</td></tr><tr><td>010b</td><td>SMI/PMI</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>Reserved</td><td>111b</td><td>ExtINT</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	Fixed	100b	NMI	001b	Lowest Priority	101b	INIT	010b	SMI/PMI	110b	Reserved	011b	Reserved	111b	ExtINT
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	Fixed	100b	NMI																		
001b	Lowest Priority	101b	INIT																		
010b	SMI/PMI	110b	Reserved																		
011b	Reserved	111b	ExtINT																		
7:0	Vector. Read-write. Reset: 0. Interrupt vector associated with this interrupt input																				

NBIOAPICx20 IRQ Pin Assertion

Bits	Description
31:8	Reserved.
7:0	InputIrq. Read-write. Reset: 0. IRQ number for the requested interrupt. A write to this register will trigger an interrupt associated with the redirection table entry referenced by the IRQ number. Currently the redirection table has 24 entries. Writes with IRQ number greater than 17h have no effect.

NBIOAPICx40 EOI

Bits	Description
31:8	Reserved.
7:0	Vector. Write-only. Reset: 0. Interrupt vector. A write to this register will clear the remote IRR bit in the redirection table entry found matching the interrupt vector. This provides an alternate mechanism other than PCI special cycle for EOI to reach IOxAPIC.

3.17 APIC Registers

See [2.4.8.1.2 \[APIC Register Space\]](#).

MMIO local APIC space is accessible in xAPIC mode.

APIC20 APIC ID

Bits	Description
31:24	ApicId: APIC ID. Read-write. Reset: Varies based on core number. <ul style="list-style-type: none"> The initial value of APIC20[ApicId[7:0]] is {0000b, CpuCoreNum[3:0]}. See 2.4.8.1.3 [ApicId Enumeration Requirements] . See 2.4.4 [Processor Cores and Downcoring] .
23:0	Reserved.

APIC30 APIC Version

Bits	Description
31	ExtApicSpace: extended APIC register space present. Read-only. Reset: 1. 1=Indicates the presence of extended APIC register space starting at APIC400 .
30:25	RAZ.
24	DirectedEoiSupport: directed EOI support. Read-only. Reset: 0. 0=Directed EOI capability not supported.
23:16	MaxLvtEntry. Read-only. Reset: Product-specific. Specifies the number of entries in the local vector table minus one.
15:8	RAZ.
7:0	Version. Read-only. Reset: 10h. Indicates the version number of this APIC implementation.

APIC80 Task Priority (TPR)

Bits	Description
31:8	RAZ.
7:0	Priority. Read-write. Reset: 0. This field is assigned by software to set a threshold priority at which the core is interrupted.

APIC90 Arbitration Priority (APR)

Bits	Description
31:8	RAZ.
7:0	Priority. Read-only. Reset: 0. Indicates the current priority for a pending interrupt, or a task or interrupt being serviced by the core. The priority is used to arbitrate between cores to determine which accepts a lowest-priority interrupt request.

APICA0 Processor Priority (PPR)

Bits	Description
31:8	RAZ.
7:0	Priority. Reset: 0. Read-only. Indicates the core's current priority servicing a task or interrupt, and is used to determine if any pending interrupts should be serviced. It is the higher value of the task priority value and the current highest in-service interrupt.

APICB0 End of Interrupt

This register is written by the software interrupt handler to indicate the servicing of the current interrupt is complete.

Bits	Description
31:0	Unused. Write-only.

APICC0 Remote Read

Bits	Description
31:0	RemoteReadData. Read-only. Reset: 0. The data resulting from a valid completion of a remote read inter-processor interrupt.

APICD0 Logical Destination (LDR)

Bits	Description
31:24	Destination. Read-write. Reset: 0. This APIC's destination identification. Used to determine which interrupts should be accepted.
23:0	Reserved.

APICE0 Destination Format

Only supported in xAPIC mode.

Bits	Description								
31:28	Format. Read-write. Reset: Fh. Controls which format to use when accepting interrupts with a logical destination mode. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>0h</td><td>Cluster destinations are used</td></tr> <tr> <td>Eh-1h</td><td>Reserved</td></tr> <tr> <td>Fh</td><td>Flat destinations are used</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0h	Cluster destinations are used	Eh-1h	Reserved	Fh	Flat destinations are used
<u>Bits</u>	<u>Definition</u>								
0h	Cluster destinations are used								
Eh-1h	Reserved								
Fh	Flat destinations are used								
27:0	Reserved. Reset: FFF_FFFFh.								

APICF0 Spurious-Interrupt Vector (SVR)

Bits	Description
31:13	RAZ.
12	EoiBroadcastDisable: EOI broadcast disable. Read-only. Reset: 0.
11:10	RAZ.
9	FocusDisable. Read-write. Reset: 0. 1=Disable focus core checking during lowest-priority arbitrated interrupts.
8	APICSWEn: APIC software enable. Read-write. Reset: 0. 0=SMI, NMI, INIT, LINT[1:0], and Startup interrupts may be accepted; pending interrupts in APIC[170:100] and APIC[270:200] are held, but further fixed, lowest-priority, and ExtInt interrupts are not accepted. All LVT entry mask bits are set and cannot be cleared.
7:0	Vector. Read-write. Reset: FFh. The vector that is sent to the core in the event of a spurious interrupt. The behavior of bits 3:0 are controlled as specified by D18F0x68[ApicExtSpur] .

APIC[170:100] In-Service (ISR)

The in-service registers provide a bit per interrupt to indicate that the corresponding interrupt is being serviced by the core. APIC100[15:0] are reserved. Interrupts are mapped as follows:

Table 203: [Register Mapping](#) for [APIC\[170:100\]](#)

Register	Function
APIC100	Interrupts [31:16]
APIC110	Interrupts [63:32]
APIC120	Interrupts [95:64]
APIC130	Interrupts [127:96]
APIC140	Interrupts [159:128]
APIC150	Interrupts [191:160]
APIC160	Interrupts [223:192]
APIC170	Interrupts [255:224]

Bits	Description
31:0	InServiceBits. Reset: 0. Read-only. These bits are set when the corresponding interrupt is being serviced by the core.

APIC[1F0:180] Trigger Mode (TMR)

The trigger mode registers provide a bit per interrupt to indicate the assertion mode of each interrupt. APIC180[15:0] are reserved. Interrupts are mapped as follows:

Table 204: [Register Mapping](#) for APIC[1F0:180]

Register	Function
APIC180	Interrupts [31:16]
APIC190	Interrupts [63:32]
APIC1A0	Interrupts [95:64]
APIC1B0	Interrupts [127:96]
APIC1C0	Interrupts [159:128]
APIC1D0	Interrupts [191:160]
APIC1E0	Interrupts [223:192]
APIC1F0	Interrupts [255:224]

Bits	Description
31:0	TriggerModeBits. Reset: 0. Read-only. The corresponding trigger mode bit is updated when an interrupt is accepted. The values are: 0=Edge-triggered interrupt. 1=Level-triggered interrupt.

APIC[270:200] Interrupt Request (IRR)

The interrupt request registers provide a bit per interrupt to indicate that the corresponding interrupt has been accepted by the APIC. APIC200[15:0] are reserved. Interrupts are mapped as follows:

Table 205: [Register Mapping](#) for APIC[270:200]

Register	Function
APIC200	Interrupts [31:16]
APIC210	Interrupts [63:32]
APIC220	Interrupts [95:64]
APIC230	Interrupts [127:96]
APIC240	Interrupts [159:128]
APIC250	Interrupts [191:160]
APIC260	Interrupts [223:192]
APIC270	Interrupts [255:224]

Bits	Description
31:0	RequestBits. Read-only. Reset: 0. The corresponding request bit is set when the an interrupt is accepted by the APIC.

APIC280 Error Status

Writes to this register trigger an update of the register state. The value written by software is arbitrary. Each write causes the internal error state to be loaded into this register, clearing the internal error state. Consequently, a second write prior to the occurrence of another error causes the register to be overwritten with cleared data.

Bits	Description
31:8	RAZ.

7	IllegalRegAddr: illegal register address. Read-write. Reset: 0. This bit indicates that an access to a nonexistent register location within this APIC was attempted. Can only be set in xAPIC mode.
6	RcvdIllegalVector: received illegal vector. Read-write. Reset: 0. This bit indicates that this APIC has received a message with an illegal vector (00h to 0Fh for fixed and lowest priority interrupts).
5	SentIllegalVector. Read-write. Reset: 0. This bit indicates that this APIC attempted to send a message with an illegal vector (00h to 0Fh for fixed and lowest priority interrupts).
4	RAZ.
3	RcvAcceptError: receive accept error. Read-write. Reset: 0. This bit indicates that a message received by this APIC was not accepted by this or any other APIC.
2	SendAcceptError. Read-write. Reset: 0. This bit indicates that a message sent by this APIC was not accepted by any APIC.
1:0	RAZ.

APIC300 Interrupt Command Low (ICR Low)

Not all combinations of ICR fields are valid. Only the following combinations are valid:

Table 206: ICR valid combinations

Message Type	Trigger Mode	Level	Destination Shorthand
Fixed	Edge	x	x
	Level	Assert	x
Lowest Priority, SMI, NMI, INIT	Edge	x	Destination or all excluding self.
	Level	Assert	Destination or all excluding self
Startup	x	x	Destination or all excluding self

Note: x indicates a don't care.

Bits	Description										
31:20	RAZ.										
19:18	<p>DestShrthnd: destination shorthand. Read-write. Reset: 0. Provides a quick way to specify a destination for a message.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>No shorthand (Destination field)</td></tr> <tr> <td>01b</td><td>Self</td></tr> <tr> <td>10b</td><td>All including self</td></tr> <tr> <td>11b</td><td>All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.)</td></tr> </table> <p>If all including self or all excluding self is used, then destination mode is ignored and physical is automatically used.</p>	<u>Bits</u>	<u>Description</u>	00b	No shorthand (Destination field)	01b	Self	10b	All including self	11b	All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.)
<u>Bits</u>	<u>Description</u>										
00b	No shorthand (Destination field)										
01b	Self										
10b	All including self										
11b	All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.)										

17:16	RemoteRdStat: remote read status. Read-only. Reset: 0. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Read was invalid</td></tr> <tr> <td>01b</td><td>Delivery pending</td></tr> <tr> <td>10b</td><td>Delivery complete and access was valid</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	Read was invalid	01b	Delivery pending	10b	Delivery complete and access was valid	11b	Reserved								
Bits	Description																		
00b	Read was invalid																		
01b	Delivery pending																		
10b	Delivery complete and access was valid																		
11b	Reserved																		
15	TM: trigger mode. Read-write. Reset: 0. Indicates how this interrupt is triggered. 0=Edge triggered. 1=Level triggered.																		
14	Level. Read-write. Reset: 0. 0=Deasserted. 1=Asserted.																		
13	RAZ.																		
12	DS: interrupt delivery status. Read-only. Reset: 0. This bit is set to indicate that the interrupt has not yet been accepted by the destination core(s). 0=Idle. 1=Send pending. Software may repeatedly write ICRL without polling the DS bit; all requested IPIs will be delivered.																		
11	DM: destination mode. Read-write. Reset: 0. 0=Physical. 1=Logical.																		
10:8	MsgType. Read-write. Reset: 0. The message types are encoded as follows: <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Fixed</td></tr> <tr> <td>001b</td><td>Lowest Priority.</td></tr> <tr> <td>010b</td><td>SMI</td></tr> <tr> <td>011b</td><td>Remote read.</td></tr> <tr> <td>100b</td><td>NMI</td></tr> <tr> <td>101b</td><td>INIT</td></tr> <tr> <td>110b</td><td>Startup</td></tr> <tr> <td>111b</td><td>External interrupt.</td></tr> </table>	Bits	Description	000b	Fixed	001b	Lowest Priority.	010b	SMI	011b	Remote read.	100b	NMI	101b	INIT	110b	Startup	111b	External interrupt.
Bits	Description																		
000b	Fixed																		
001b	Lowest Priority.																		
010b	SMI																		
011b	Remote read.																		
100b	NMI																		
101b	INIT																		
110b	Startup																		
111b	External interrupt.																		
7:0	Vector. Read-write. Reset: 0. The vector that is sent for this interrupt source.																		

APIC310 Interrupt Command High (ICR High)

Bits	Description
31:24	DestinationField. Read-write. Reset: 0. The destination encoding used when APIC300[DestShrthnd] is 00b.
23:0	RAZ.

APIC320 LVT Timer

Bits	Description
31:18	RAZ.
17	Mode. Read-write. Reset: 0. 0=One-shot. 1=Periodic.
16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15:13	RAZ.
12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.

10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table] .
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

APIC330 LVT Thermal Sensor

Interrupts for this local vector table are caused by changes in [MSRC001_0061\[CurPstateLimit\]](#) due to SB-RMI or HTC.

Bits	Description
31:17	RAZ.
16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15:13	RAZ.
12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.
10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table] .
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

APIC340 LVT Performance Monitor

Interrupts for this local vector table are caused by overflows of:

- [MSRC001_00\[07:04\] \[Performance Event Counter \(PERF_CTR\[3:0\]\)\]](#).
- [MSRC001_024\[7,5,3,1\] \[Northbridge Performance Event Counter \(NB_PERF_CTR\[3:0\]\)\]](#).

Bits	Description
31:17	RAZ.
16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15:13	RAZ.
12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.
10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table] .
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

APIC3[60:50] LVT LINT[1:0]

Table 207: [Register Mapping](#) for APIC3[60:50]

Register	Function
APIC350	LINT 0
APIC360	LINT 1

Bits	Description
31:17	RAZ.

16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15	TM: trigger mode. Read-write. Reset: 0. 0=Edge. 1=Level.
14	RmtIRR. Read-only; updated-by-hardware. Reset: 0. If trigger mode is level, remote IRR is set when the interrupt has begun service. Remote IRR is cleared when the end of interrupt has occurred.
13	Reserved.
12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.
10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table] .
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

APIC370 LVT Error

Bits	Description
31:17	RAZ.
16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15:13	Reserved.
12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.
10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table] .
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

APIC380 Timer Initial Count

Bits	Description
31:0	Count. Read-write. Reset: 0. The value copied into the current count register when the timer is loaded or reloaded.

APIC390 Timer Current Count

Bits	Description
31:0	Count. Read-only. Reset: 0. The current value of the counter.

APIC3E0 Timer Divide Configuration

The Div bits are encoded as follows:

Table 208: Div[3,1:0] Value Table

Div[3]	Div[1:0]	Resulting Timer Divide
0	00b	2
0	01b	4

Table 208: Div[3,1:0] Value Table

Div[3]	Div[1:0]	Resulting Timer Divide
0	10b	8
0	11b	16
1	00b	32
1	01b	64
1	10b	128
1	11b	1

Bits	Description
31:4	RAZ.
3	Div[3] . Read-write. Reset: 0. See Table 208 .
2	RAZ.
1:0	Div[1:0] . Read-write. Reset: 0. See Table 208 .

APIC400 Extended APIC Feature

Bits	Description
31:24	RAZ.
23:16	ExtLvtCount: extended local vector table count . Read-only. Reset: 04h. This specifies the number of extended LVT registers (APIC[530:500]) in the local APIC.
15:3	RAZ.
2	ExtApicIdCap: extended APIC ID capable . Read-only. Reset: 1. 1=The processor is capable of supporting an 8-bit APIC ID, as controlled by APIC410[ExtApicIdEn] .
1	SeoiCap: specific end of interrupt capable . Read-only. Reset: 1. 1=The APIC420 [Specific End Of Interrupt] is present.
0	IerCap: interrupt enable register capable . Read-only. Reset: 1. This bit indicates that the APIC[4F0:480] [Interrupt Enable] are present. See 2.4.8.1.8 [Interrupt Masking] .

APIC410 Extended APIC Control

Bits	Description
31:3	RAZ.
2	ExtApicIdEn: extended APIC ID enable . Read-write. Reset: 0. 1=Enable 8-bit APIC ID; APIC20[ApicId] supports an 8-bit value; an interrupt broadcast in physical destination mode requires that the IntDest[7:0]=1111_1111b (instead of xxxx_1111b); a match in physical destination mode occurs when (IntDest[7:0] == ApicId[7:0]) instead of (IntDest[3:0] == ApicId[3:0]). If ExtApicIdEn=1 then program D18F0x68[ApicExtId]=1 and D18F0x68[ApicExtBrdCst]=1 .
1	SeoiEn . Read-write. Reset: 0. 1=Enable SEOI generation when a write to APIC420 [Specific End Of Interrupt] is received.
0	IerEn . Read-write. Reset: 0. 1=Enable writes to the interrupt enable registers.

APIC420 Specific End Of Interrupt

Bits	Description
31:8	RAZ.
7:0	EoiVec: end of interrupt vector. Read-write. Reset: 0. A write to this field causes an end of interrupt cycle to be performed for the vector specified in this field. The behavior is undefined if no interrupt is pending for the specified interrupt vector.

APIC[4F0:480] Interrupt Enable

Interrupt enables range is mapped as follows:

Table 209: [Register Mapping](#) for APIC[4F0:480]

Register	Function
APIC480	IntEn[31:0]
APIC490	IntEn[63:32]
APIC4A0	IntEn[95:64]
APIC4B0	IntEn[127:96]
APIC4C0	IntEn[159:128]
APIC4D0	IntEn[191:160]
APIC4E0	IntEn[223:192]
APIC4F0	IntEn[255:224]

Bits	Description
31:0	InterruptEnableBits. Read-write. Reset: FFFF_FFFFh. The interrupt enable bits can be used to enable each of the 256 interrupts. See above table.

APIC[530:500] Extended Interrupt [3:0] Local Vector Table

APIC500 provides a local vector table entry for IBS; See [D18F3x1CC](#). APIC510 provides a local vector table entry for error thresholding. The APIC[530:520] registers are unused.

Table 210: [Register Mapping](#) for APIC[530:500]

Register	Function
APIC500	Extended Interrupt 0 (IBS)
APIC510	Extended Interrupt 1 (Thresholding)
APIC520	Extended Interrupt 2
APIC530	Extended Interrupt 3

Bits	Description
31:17	RAZ.
16	Mask. Read-write. Reset: 1. 0=Not masked. 1=Masked.
15:13	RAZ.

12	DS: interrupt delivery status. Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)
11	RAZ.
10:8	MsgType: message type. Read-write. Reset: 000b. See 2.4.8.1.14 [Generalized Local Vector Table].
7:0	Vector. Read-write. Reset: 00h. Interrupt vector number.

3.18 CPUID Instruction Registers

Processor feature capabilities and configuration information are provided through the CPUID instruction. The information is accessed by (1) selecting the CPUID function setting EAX and optionally ECX for some functions, (2) executing the CPUID instruction, and (3) reading the results in the EAX, EBX, ECX, and EDX registers. The syntax *CPUID FnXXXX_XXXX_EiX[_xYYY]* refers to the function where EAX==X, and optionally ECX==Y, and the registers specified by EiX. EiX can be any single register such as {EAX, EBX, ECX, and EDX}, or a range of registers, such as E[C,B,A]X. Undefined function numbers return 0's in all 4 registers. See 2.4.10 [CPUID Instruction].

Unless otherwise specified, single-bit feature fields are encoded as 1=Feature is supported by the processor; 0=Feature is not supported by the processor.

The following provides processor specific details about CPUID.

CPUID Fn0000_0000_EAX Processor Vendor and Largest Standard Function Number

Bits	Description
31:0	LFuncStd: largest standard function. Value: 0000_000Dh. The largest CPUID standard function input value supported by the processor implementation.

CPUID Fn0000_0000_E[D,C,B]X Processor Vendor

CPUID Fn0000_0000_E[D,C,B]X and CPUID Fn8000_0000_E[D,C,B]X return the same value.

Table 211: Reset Mapping for CPUID Fn8000_0000_E[D,C,B]X

Register	Value	Description
CPUID Fn0000_0000_EBX	6874_7541h	The ASCII characters “h t u A”.
CPUID Fn0000_0000_ECX	444D_4163h	The ASCII characters “D M A c”.
CPUID Fn0000_0000_EDX	6974_6E65h	The ASCII characters “i t n e”.

Bits	Description
31:0	Vendor. The 12 8-bit ASCII character codes to create the string “AuthenticAMD”.

CPUID Fn0000_0001_EAX Family, Model, Stepping Identifiers

Also see CPUID Fn8000_0001_EAX [Family, Model, Stepping Identifiers].

Family is an 8-bit value and is defined as: **Family**[7:0] = ({0000b, BaseFamily[3:0]} + ExtendedFamily[7:0]). E.g. If BaseFamily[3:0]=Fh and ExtendedFamily[7:0]=07h, then Family[7:0]=16h.

Model is an 8-bit value and is defined as: **Model**[7:0] = {ExtendedModel[3:0], BaseModel[3:0]}. E.g. If

ExtendedModel[3:0]=Eh and BaseModel[3:0]=8h, then Model[7:0] = E8h. Model numbers vary with product.

Bits	Description
31:28	Reserved.
27:20	ExtFamily: extended family. Alias of D18F3xFC [ExtFamily].
19:16	ExtModel: extended model. Alias of D18F3xFC [ExtModel].
15:12	Reserved.
11:8	BaseFamily. Alias of D18F3xFC [BaseFamily].
7:4	BaseModel. Alias of D18F3xFC [BaseModel].
3:0	Stepping. Alias of D18F3xFC [Stepping].

CPUID Fn0000_0001_EBX LocalApicId, LogicalProcessorCount, CLFlush

Bits	Description
31:24	LocalApicId: initial local APIC physical ID. The initial APIC20 [ApicId] value. See 2.4.4 [Processor Cores and Downcoring] .
23:16	LogicalProcessorCount: logical processor count. Value: CPUID Fn8000_0008_ECX [NC] + 1. Specifies the number of cores in the processor as CPUID Fn8000_0008_ECX [NC] + 1.
15:8	CLFlush: CLFLUSH size in quadwords. Value: 08h.
7:0	8BitBrandId: 8 bit brand ID. Value: 00h. Indicates that the brand ID is in CPUID Fn8000_0001_EBX .

CPUID Fn0000_0001_ECX Feature Identifiers

These values can be over-written by [MSRC001_1004](#).

Bits	Description
31	RAZ. Reserved for use by hypervisor to indicate guest status.
30	RDRAND: RDRAND instruction support. Value: 1.
29	F16C: half-precision convert instruction support. Value: 1.
28	AVX: AVX instruction support. Value: 1. Value: 1.
27	OSXSAVE: OS enabled support for XGETBV/XSETBV. 1=The OS has enabled support for XGETBV/XSETBV instructions to query processor extended states.
26	XSAVE: XSAVE (and related) instruction support. Value: 1. 1=Support provided for the XSAVE, XRSTOR, XSETBV, and XGETBV instructions and the XFEATURE_ENABLED_MASK register.

25	AES: AES instruction support. Value: Product-specific.
24	Reserved.
23	POPCNT: POPCNT instruction. Value: 1.
22	MOVBE: MOVBE instruction support. Value: 1.
21	x2APIC: x2APIC capability. Value: 0.
20	SSE42: SSE4.2 instruction support. Value: 1.
19	SSE41: SSE4.1 instruction support. Value: 1.
18	Reserved.
17	PCID: process context identifiers support. Value: 0.
16:14	Reserved.
13	CMPXCHG16B: CMPXCHG16B instruction. Value: 1.
12	FMA: FMA instruction support. Value: 0.
11:10	Reserved.
9	SSSE3: supplemental SSE3 extensions. Value: 1.
8:4	Reserved.
3	Monitor: Monitor/Mwait instructions. Value: ~ MSRC001_0015 [MonMwaitDis].
2	Reserved.
1	PCLMULQDQ: PCLMULQDQ instruction support. Value: Product-specific.
0	SSE3: SSE3 extensions. Value: 1.

CPUID Fn0000_0001_EDX Feature Identifiers

These values can be over-written by [MSRC001_1004](#).

Bits	Description
31:29	Reserved.
28	HTT: hyper-threading technology. Value: CPUID Fn8000_0008_ECX [NC]!=0. 1=Multi core product (CPUID Fn8000_0008_ECX [NC] != 0). 0=Single core product (CPUID Fn8000_0008_ECX [NC]==0).
27	Reserved.

26	SSE2: SSE2 extensions. Value: 1.
25	SSE: SSE extensions. Value: 1.
24	FXSR: FXSAVE and FXRSTOR instructions. Value: 1.
23	MMX: MMX™ instructions. Value: 1.
22:20	Reserved.
19	CLFSH: CLFLUSH instruction. Value: 1.
18	Reserved.
17	PSE36: page-size extensions. Value: 1.
16	PAT: page attribute table. Value: 1.
15	CMOV: conditional move instructions, CMOV, FCOMI, FCMOV. Value: 1.
14	MCA: machine check architecture, MCG_CAP. Value: 1.
13	PGE: page global extension, CR4.PGE. Value: 1.
12	MTRR: memory-type range registers. Value: 1.
11	SysEnterSysExit: SYSENTER and SYSEXIT instructions. Value: 1.
10	Reserved.
9	APIC: advanced programmable interrupt controller (APIC) exists and is enabled. Value: MSR0000_001B [ApicEn].
8	CMPXCHG8B: CMPXCHG8B instruction. Value: 1.
7	MCE: machine check exception, CR4.MCE. Value: 1.
6	PAE: physical-address extensions (PAE). Value: 1.
5	MSR: AMD model-specific registers (MSRs), with RDMSR and WRMSR instructions. Value: 1.
4	TSC: time stamp counter, RDTSC/RDTSCP instructions, CR4.TSD. Value: 1.
3	PSE: page-size extensions (4 MB pages). Value: 1.
2	DE: debugging extensions, IO breakpoints, CR4.DE. Value: 1.
1	VME: virtual-mode enhancements. Value: 1.
0	FPU: x87 floating point unit on-chip. Value: 1.

CPUID Fn0000_000[4:2] Reserved

Bits	Description
31:0	Reserved.

CPUID Fn0000_0005_EAX Monitor/MWait

Bits	Description
31:16	Reserved.
15:0	MonLineSizeMin: smallest monitor-line size in bytes. Value: 40h.

CPUID Fn0000_0005_EBX Monitor/MWait

Bits	Description
31:16	Reserved.
15:0	MonLineSizeMax: largest monitor-line size in bytes. Value: 40h.

CPUID Fn0000_0005_ECX Monitor/MWait

Bits	Description
31:2	Reserved.
1	IBE: interrupt break-event. Value: 1.
0	EMX: enumerate MONITOR/MWAIT extensions. Value: 1.

CPUID Fn0000_0005_EDX Monitor/MWait

Bits	Description
31:0	Reserved.

CPUID Fn0000_0006_EAX Thermal and Power Management

Bits	Description
31:3	Reserved.
2	ARAT: always running APIC timer. Value: 0. 1=Indicates support for APIC timer always running feature.
1:0	Reserved.

CPUID Fn0000_0006_EBX Thermal and Power Management

Bits	Description
31:0	Reserved.

CPUID Fn0000_0006_ECX Thermal and Power Management

Bits	Description
31:1	Reserved.
0	EffFreq: effective frequency interface. Value: 1. 1=Indicates presence of MSR0000_00E7 [Max Performance Frequency Clock Count (MPERF)] and MSR0000_00E8 [Actual Performance Frequency Clock Count (APERF)] .

CPUID Fn0000_0006_EDX Thermal and Power Management

Bits	Description
31:0	Reserved.

CPUID Fn0000_0007_EAX_x0 Structured Extended Feature Identifiers (ECX=0)

Bits	Description
31:0	Reserved.

CPUID Fn0000_0007_EBX_x0 Structured Extended Feature Identifiers (ECX=0)

Bits	Description
31:11	Reserved.
10	INVPCID: invalidate processor context ID. Value: 0.
9	Reserved.
8	BMI2: bit manipulation group 2 instruction support. Value: 0.
7	SMEP: supervisor mode execution protection. Value: 0.
6	Reserved.
5	AVX2: AVX extension support. Value: 0.
4	Reserved.
3	BMI1: bit manipulation group 1 instruction support. Value: 1.
2:1	Reserved.
0	FSGSBASE: FS and GS base read write instruction support. Value: 0.

CPUID Fn0000_0007_ECX_x0 Structured Extended Feature Identifiers (ECX=0)

Bits	Description
31:0	Reserved.

CPUID Fn0000_0007_EDX_x0 Structured Extended Feature Identifiers (ECX=0)

Bits	Description
31:0	Reserved.

CPUID Fn0000_000[A:8] Reserved

Bits	Description
31:0	Reserved.

CPUID Fn0000_000B Reserved

Bits	Description
31:0	Reserved.

CPUID Fn0000_000C Reserved

Bits	Description
31:0	Reserved.

CPUID Fn0000_000D_EAX_x0 Processor Extended State Enumeration (ECX=0)

Bits	Description
31:0	XFeatureSupportedMask[31:0] . Value: 0000_0007h.

CPUID Fn0000_000D_EBX_x0 Processor Extended State Enumeration (ECX=0)

Bits	Description
31:0	<p>XFeatureEnabledSizeMax. Size in bytes of XSAVE/XRSTOR area for the currently enabled features in XCR0. Value: $512 + 64 + (\text{IF } (\text{XCR0}[\text{AVX}]) \text{ THEN } 256 \text{ ELSE } 0 \text{ ENDIF})$. The components of this sum are described as follows:</p> <ul style="list-style-type: none"> • 512: FPU/SSE save area (needed even if $\text{XCR0}[\text{SSE}] = 0$) • 64: Header size (always needed). • Size of YMM area if YMM enabled.

CPUID Fn0000_000D_ECX_x0 Processor Extended State Enumeration (ECX=0)

Bits	Description
31:0	XFeatureSupportedSizeMax. Size in bytes of XSAVE/XRSTOR area for all features that the core supports. See XFeatureEnabledSizeMax. Value: 0000_0340h.

CPUID Fn0000_000D_EDX_x0 Processor Extended State Enumeration (ECX=0)

Bits	Description
31:0	XFeatureSupportedMask[63:32]. Value: 0000_0000h.

CPUID Fn0000_000D_EAX_x1 Processor Extended State Enumeration (ECX=1)

Bits	Description
31:1	Reserved.
0	XSAVEOPT: XSAVEOPT is available. Value: 1.

CPUID Fn0000_000D_E[D,C,B]X_x1 Processor Extended State Enumeration (ECX=1)

Bits	Description
31:0	Reserved.

CPUID Fn0000_000D_EAX_x2 Processor Extended State Enumeration (ECX=2)

Bits	Description
31:0	YmmSaveStateSize: YMM save state byte size. Value: 0000_0100h.

CPUID Fn0000_000D_EBX_x2 Processor Extended State Enumeration (ECX=2)

Bits	Description
31:0	YmmSaveStateOffset: YMM save state byte offset. Value: 0000_0240h.

CPUID Fn0000_000D_ECX_x2 Processor Extended State Enumeration (ECX=2)

Bits	Description
31:0	Reserved.

CPUID Fn0000_000D_EDX_x2 Processor Extended State Enumeration (ECX=2)

Bits	Description
31:0	Reserved.

For CPUID Fn0000_000D, if ECX>2 then EAX/EBX/ECX/EDX will return 0.

CPUID Fn8000_0000_EAX Largest Extended Function Number

Bits	Description
31:0	LFuncExt: largest extended function. Value: 8000_001Eh. The largest CPUID extended function input value supported by the processor implementation.

CPUID Fn8000_0000_E[D,C,B]X Processor Vendor

[CPUID Fn0000_0000_E\[D,C,B\]X](#) and [CPUID Fn8000_0000_E\[D,C,B\]X](#) return the same value.

Table 212: CPUID Fn8000_0000_E[B,C,D]X Value

Register	Value	Description
CPUID Fn8000_0000_EBX	6874_7541h	The ASCII characters “h t u A”.
CPUID Fn8000_0000_ECX	444D_4163h	The ASCII characters “D M A c”.
CPUID Fn8000_0000_EDX	6974_6E65h	The ASCII characters “i t n e”.

Bits	Description
31:0	Vendor. The 12 8-bit ASCII character codes to create the string “AuthenticAMD”.

CPUID Fn8000_0001_EAX Family, Model, Stepping Identifiers

Also see [CPUID Fn0000_0001_EAX \[Family, Model, Stepping Identifiers\]](#).

Bits	Description
31:28	Reserved.
27:20	ExtFamily: extended family. CPUID Fn8000_0001_EAX[ExtFamily] is an alias of D18F3xFC[ExtFamily] .
19:16	ExtModel: extended model. CPUID Fn8000_0001_EAX[ExtModel] is an alias of D18F3xFC[ExtModel] .
15:12	Reserved.
11:8	BaseFamily. CPUID Fn8000_0001_EAX[BaseFamily] is an alias of D18F3xFC[BaseFamily] .

7:4	BaseModel. CPUID Fn8000_0001_EAX [BaseModel] is an alias of D18F3xFC [BaseModel].
3:0	Stepping. CPUID Fn8000_0001_EAX [Stepping] is an alias of D18F3xFC [Stepping].

CPUID Fn8000_0001_EBX BrandId Identifier

Bits	Description										
31:28	PkgType: package type. Specifies the package type. Value: 0h. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>FT3b (BGA)</td></tr> <tr> <td>2h-1h</td><td>Reserved</td></tr> <tr> <td>3h</td><td>FP4</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Description	0h	FT3b (BGA)	2h-1h	Reserved	3h	FP4	Fh-4h	Reserved
Bits	Description										
0h	FT3b (BGA)										
2h-1h	Reserved										
3h	FP4										
Fh-4h	Reserved										
27:0	Reserved.										

CPUID Fn8000_0001_ECX Feature Identifiers

These values can be over-written by [MSRC001_1005](#).

Bits	Description
31:29	Reserved.
28	PerfCtrExtL2I: L2I performance counter extensions support. Value: 1. Indicates support for MSRC001_023 [6,4,2,0] and MSRC001_023 [7,5,3,1].
27	PerfTsc: performance time-stamp counter supported. Value: 1. Indicates support for MSRC001_0280 [Performance Time Stamp Counter (CU_PTSC)].
26	DataBreakpointExtension. Value: 1. Indicates data breakpoint support for MSRC001_1027 and MSRC001_101 [B:9].
25	Reserved.
24	PerfCtrExtNB: NB performance counter extensions support. Value: 1. Indicates support for MSRC001_024 [6,4,2,0] and MSRC001_024 [7,5,3,1].
23	PerfCtrExtCore: core performance counter extensions support. Value: 0. Indicates support for MSRC001_020 [A,8,6,4,2,0] and MSRC001_020 [B,9,7,5,3,1].
22	TopologyExtensions: topology extensions support. Value: 1. Indicates support for CPUID Fn8000_001D_EAX_x0 - CPUID Fn8000_001E_EDX .
21	TBM: trailing bit manipulation instruction support. Value: 0.
20	Reserved.
19	Reserved.
18	Reserved.

17	TCE: translation cache extension. Value: 0.
16	FMA4: 4-operand FMA instruction support. Value: 0.
15	LWP: lightweight profiling support. Value: 0.
14	Reserved.
13	WDT: watchdog timer support. Value: 1.
12	SKINIT: SKINIT and STGI support. Value: 1.
11	XOP: extended operation support. Value: 0.
10	IBS: Instruction Based Sampling. Value: 1.
9	OSVW: OS Visible Work-around support. Value: 1.
8	3DNowPrefetch: Prefetch and PrefetchW instructions. Value: 1.
7	MisAlignSse: Misaligned SSE Mode. Value: 1.
6	SSE4A: EXTRQ, INSERTQ, MOVNTSS, and MOVNTSD instruction support. Value: 1.
5	ABM: advanced bit manipulation. Value: 1. LZCNT instruction support.
4	AltMovCr8: LOCK MOV CR0 means MOV CR8. Value: 1.
3	ExtApicSpace: extended APIC register space. Value: 1.
2	SVM: Secure Virtual Mode feature. Value: Product-specific. Indicates support for: VMRUN, VMLOAD, VMSAVE, CLGI, VMMCALL, and INVLPGA.
1	CmpLegacy: core multi-processing legacy mode. Value: Product-specific. 1=Multi core product (CPUID Fn8000_0008_ECX[NC] != 0). 0=Single core product (CPUID Fn8000_0008_ECX[NC] == 0).
0	LahfSahf: LAHF/SAHF instructions. Value: 1.

CPUID Fn8000_0001_EDX Feature Identifiers

These values can be over-written by [MSRC001_1005](#).

Bits	Description
31	3DNow: 3DNow!™ instructions. Value: 0.
30	3DNowExt: AMD extensions to 3DNow!™ instructions. Value: 0.
29	LM: long mode. Value: 1.
28	Reserved.
27	RDTSCP: RDTSCP instruction. Value: 1.

26	Page1GB: one GB large page support. Value: 1.
25	FFXSR: FXSAVE and FXRSTOR instruction optimizations. Value: 1.
24	FXSR: FXSAVE and FXRSTOR instructions. Value: 1.
23	MMX: MMX™ instructions. Value: 1.
22	MmxExt: AMD extensions to MMX instructions. Value: 1.
21	Reserved.
20	NX: no-execute page protection. Value: 1.
19:18	Reserved.
17	PSE36: page-size extensions. Value: 1.
16	PAT: page attribute table. Value: 1.
15	CMOV: conditional move instructions, CMOV, FCOMI, FCMOV. Value: 1.
14	MCA: machine check architecture, MCG_CAP. Value: 1.
13	PGE: page global extension, CR4.PGE. Value: 1.
12	MTRR: memory-type range registers. Value: 1.
11	SysCallSysRet: SYSCALL and SYSRET instructions. Value: 1.
10	Reserved.
9	APIC: advanced programmable interrupt controller (APIC) exists and is enabled. Value: MSR0000_001B [ApicEn].
8	CMPXCHG8B: CMPXCHG8B instruction. Value: 1.
7	MCE: machine check exception, CR4.MCE. Value: 1.
6	PAE: physical-address extensions (PAE). Value: 1.
5	MSR: model-specific registers (MSRs), with RDMSR and WRMSR instructions. Value: 1.
4	TSC: time stamp counter, RDTSC/RDTSCP instructions, CR4.TSD. Value: 1.
3	PSE: page-size extensions (4 MB pages). Value: 1.
2	DE: debugging extensions, IO breakpoints, CR4.DE. Value: 1.
1	VME: virtual-mode enhancements. Value: 1.
0	FPU: x87 floating point unit on-chip. Value: 1.

CPUID Fn8000_000[4:2]_E[D,C,B,A]X Processor Name String Identifier

Table 213: [Valid Values](#) for [CPUID Fn8000_000\[4:2\]_E\[D,C,B,A\]X](#)

Register	Value
CPUID Fn8000_0002_EAX	MSRC001_0030[31:0]
CPUID Fn8000_0002_EBX	MSRC001_0030[63:32]
CPUID Fn8000_0002_ECX	MSRC001_0031[31:0]
CPUID Fn8000_0002_EDX	MSRC001_0031[63:32]
CPUID Fn8000_0003_EAX	MSRC001_0032[31:0]
CPUID Fn8000_0003_EBX	MSRC001_0032[63:32]
CPUID Fn8000_0003_ECX	MSRC001_0033[31:0]
CPUID Fn8000_0003_EDX	MSRC001_0033[63:32]

Table 213: [Valid Values](#) for [CPUID Fn8000_000\[4:2\]_E\[D,C,B,A\]X](#)

CPUID Fn8000_0004_EAX	MSRC001_0034[31:0]
CPUID Fn8000_0004_EBX	MSRC001_0034[63:32]
CPUID Fn8000_0004_ECX	MSRC001_0035[31:0]
CPUID Fn8000_0004_EDX	MSRC001_0035[63:32]

Bits	Description
31:0	ProcName: processor name. These return the ASCII string corresponding to the processor name, stored in MSRC001_00[35:30] [Processor Name String].

CPUID Fn8000_0005_EAX L1 TLB 2M/4M Identifiers

This function provides the processor's first level cache and TLB characteristics for each core.

Bits	Description
31:24	L1DTlb2and4MAssoc: data TLB associativity for 2 MB and 4 MB pages. Value: FFh. See: CPUID Fn8000_0005_ECX [L1DcAssoc].
23:16	L1DTlb2and4MSize: data TLB number of entries for 2 MB and 4 MB pages. Value: 8. The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value.
15:8	L1ITlb2and4MAssoc: instruction TLB associativity for 2 MB and 4 MB pages. Value: FFh. See: CPUID Fn8000_0005_ECX [L1DcAssoc].
7:0	L1ITlb2and4MSize: instruction TLB number of entries for 2 MB and 4 MB pages. Value: 8. The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value.

CPUID Fn8000_0005_EBX L1 TLB 4K Identifiers

See: [CPUID Fn8000_0005_EAX](#).

Bits	Description
31:24	L1DTlb4KAssoc: data TLB associativity for 4 KB pages. Value: FFh. See: CPUID Fn8000_0005_ECX [L1DcAssoc].
23:16	L1DTlb4KSize: data TLB number of entries for 4 KB pages. Value: 40.
15:8	L1ITlb4KAssoc: instruction TLB associativity for 4 KB pages. Value: FFh. ITLB associativity for 4 KB pages is reported by CPUID Fn8000_0006_EBX [L2ITlb4KAssoc].
7:0	L1ITlb4KSize: instruction TLB number of entries for 4 KB pages. Value: 32. ITLB size for 4 KB pages is reported by CPUID Fn8000_0006_EBX [L2ITlb4KSize].

CPUID Fn8000_0005_ECX L1 Data Cache Identifiers

This function provides first level cache characteristics for each core.

Bits	Description														
31:24	L1DcSize: L1 data cache size in KB. Value: 32.														
23:16	L1DcAssoc: L1 data cache associativity. Value: 8. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>01h</td><td>1 way (direct mapped)</td></tr> <tr> <td>02h</td><td>2 way</td></tr> <tr> <td>03h</td><td>3 way</td></tr> <tr> <td>FEh-04h</td><td>[L1IcAssoc] way</td></tr> <tr> <td>FFh</td><td>Fully associative</td></tr> </table>	Bits	Description	00h	Reserved	01h	1 way (direct mapped)	02h	2 way	03h	3 way	FEh-04h	[L1IcAssoc] way	FFh	Fully associative
Bits	Description														
00h	Reserved														
01h	1 way (direct mapped)														
02h	2 way														
03h	3 way														
FEh-04h	[L1IcAssoc] way														
FFh	Fully associative														
15:8	L1DcLinesPerTag: L1 data cache lines per tag. Value: 1.														
7:0	L1DcLineSize: L1 data cache line size in bytes. Value: 64.														

CPUID Fn8000_0005_EDX L1 Instruction Cache Identifiers

This function provides first level cache characteristics for each core.

Bits	Description
31:24	L1IcSize: L1 instruction cache size KB. Value: 32.
23:16	L1IcAssoc: L1 instruction cache associativity. Value: 2. See: CPUID Fn8000_0005_ECX [L1DcAssoc].
15:8	L1IcLinesPerTag: L1 instruction cache lines per tag. Value: 1.
7:0	L1IcLineSize: L1 instruction cache line size in bytes. Value: 64.

CPUID Fn8000_0006_EAX L2 TLB 2M/4M Identifiers

This function provides the processor's second level cache and TLB characteristics for each core.

Bits	Description
31:28	L2DTlb2and4MAssoc: L2 data TLB associativity for 2 MB and 4 MB pages. Value: 2. See: CPUID Fn8000_0006_ECX [L2Assoc].
27:16	L2DTlb2and4MSize: L2 data TLB number of entries for 2 MB and 4 MB pages. Value: 256. The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value.

15:12	L2ITlb2and4MAssoc: L2 instruction TLB associativity for 2 MB and 4 MB pages. Value: 0. See: CPUID Fn8000_0006_ECX[L2Assoc] .
11:0	L2ITlb2and4MSize: L2 instruction TLB number of entries for 2 MB and 4 MB pages. Value: 0. The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value.

CPUID Fn8000_0006_EBX L2 TLB 4K Identifiers

This function provides second level TLB characteristics for 4K pages shared by each core on a L2 complex.

Bits	Description
31:28	L2DTlb4KAssoc: L2 data TLB associativity for 4 KB pages. Value: 4. See: CPUID Fn8000_0006_ECX[L2Assoc] .
27:16	L2DTlb4KSize: L2 data TLB number of entries for 4 KB pages. Value: 512.
15:12	L2ITlb4KAssoc: L2 instruction TLB associativity for 4 KB pages. Value: 4. See: CPUID Fn8000_0006_ECX[L2Assoc] .
11:0	L2ITlb4KSize: L2 instruction TLB number of entries for 4 KB pages. Value: 512.

CPUID Fn8000_0006_ECX L2 Cache Identifiers

Bits	Description																																				
31:16	L2Size: L2 cache size in KB. Value: Product-specific. <table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>03FFh-0000h</td><td>Reserved</td></tr><tr><td>0400h</td><td>1 MB</td></tr><tr><td>07FFh-0401h</td><td>Reserved</td></tr><tr><td>0800h</td><td>2 MB</td></tr><tr><td>FFFFh-0801h</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Description</u>	03FFh-0000h	Reserved	0400h	1 MB	07FFh-0401h	Reserved	0800h	2 MB	FFFFh-0801h	Reserved																								
<u>Bits</u>	<u>Description</u>																																				
03FFh-0000h	Reserved																																				
0400h	1 MB																																				
07FFh-0401h	Reserved																																				
0800h	2 MB																																				
FFFFh-0801h	Reserved																																				
15:12	L2Assoc: L2 cache associativity. Value: 8. <table><tr><th><u>Bits</u></th><th><u>Description</u></th><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>0h</td><td>Disabled.</td><td>8h</td><td>16 ways</td></tr><tr><td>1h</td><td>1 way (direct mapped)</td><td>9h</td><td>Reserved</td></tr><tr><td>2h</td><td>2 ways</td><td>Ah</td><td>32 ways</td></tr><tr><td>3h</td><td>Reserved</td><td>Bh</td><td>48 ways</td></tr><tr><td>4h</td><td>4 ways</td><td>Ch</td><td>64 ways</td></tr><tr><td>5h</td><td>Reserved</td><td>Dh</td><td>96 ways</td></tr><tr><td>6h</td><td>8 ways</td><td>Eh</td><td>128 ways</td></tr><tr><td>7h</td><td>Reserved</td><td>Fh</td><td>Fully associative</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	0h	Disabled.	8h	16 ways	1h	1 way (direct mapped)	9h	Reserved	2h	2 ways	Ah	32 ways	3h	Reserved	Bh	48 ways	4h	4 ways	Ch	64 ways	5h	Reserved	Dh	96 ways	6h	8 ways	Eh	128 ways	7h	Reserved	Fh	Fully associative
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																																		
0h	Disabled.	8h	16 ways																																		
1h	1 way (direct mapped)	9h	Reserved																																		
2h	2 ways	Ah	32 ways																																		
3h	Reserved	Bh	48 ways																																		
4h	4 ways	Ch	64 ways																																		
5h	Reserved	Dh	96 ways																																		
6h	8 ways	Eh	128 ways																																		
7h	Reserved	Fh	Fully associative																																		

11:8	L2LinesPerTag: L2 cache lines per tag. Value: 1.
7:0	L2LineSize: L2 cache line size in bytes. Value: 64.

CPUID Fn8000_0006_EDX L3 Cache Identifiers

This function provides third level cache characteristics shared by all cores.

Bits	Description
31:18	L3Size: L3 cache size. Value: 0.
17:16	Reserved.
15:12	L3Assoc: L3 cache associativity. Value: 0.
11:8	L3LinesPerTag: L3 cache lines per tag. Value: 0.
7:0	L3LineSize: L3 cache line size in bytes. Value: 0.

CPUID Fn8000_0007_EAX Processor Feedback Capabilities

Bits	Description
31:16	MaxWrapTime. Value: 0000h. Specifies the maximum time between reads that software should use to avoid two wraps. A read of at least once every MaxWrapTime seconds will result in either zero or one wrap during that interval.
15:8	Version. Value: 00h. Specifies the processor feedback capabilities version.
7:0	NumberOfMonitors. Value: 00h. Specifies the number of processor feedback MSR pairs supported. Valid if (CPUID Fn8000_0007_EDX [ProcFeedbackInterface]==1).

CPUID Fn8000_0007_EBX RAS Capabilities

Bits	Description
31:3	Reserved.
2	HWA: hardware assert supported. 1=Indicates support for MSRC001_10[DF:C0]. Value: 0.
1	SUCCOR: Software uncorrectable error containment and recovery capability. Value: 0.
0	McaOverflowRecov: MCA overflow recovery support. Value: 1. 1=MCA overflow conditions (MCi_STATUS[Overflow]=1) are not fatal; software may safely ignore such conditions. 0=MCA overflow conditions require software to shut down the system. See 2.16.1.6 [Handling Machine Check Exceptions] .

CPUID Fn8000_0007_ECX Advanced Power Management Information

Bits	Description
31:0	CmpUnitPwrSampleTimeRatio . Specifies the compute unit power accumulator sample period.

CPUID Fn8000_0007_EDX Advanced Power Management Information

This function provides advanced power management feature identifiers.

Bits	Description
31:13	Reserved.
12	ApmPwrReporting: APM power reporting . Value: 1. 1=Indicates support for processor Power Accumulator. See MSRC001_007A , MSRC001_007B and MSRC001_0280 .
11	ProcFeedbackInterface: processor feedback interface . Value: 0. 1=Indicates support for processor feedback interface; CPUID Fn8000_0007_EAX .
10	EffFreqRO: read-only effective frequency interface . Value: 0. 1=Indicates presence of MSRC000_00E7 [Read-Only Max Performance Frequency Clock Count (MPerfReadOnly)] and MSRC000_00E8 [Read-Only Actual Performance Frequency Clock Count (APerfReadOnly)].
9	CPB: core performance boost . Value: Product-specific. 1= Indicates presence of MSRC001_0015 [CpbDis] and support for core performance boost. See 2.5.9 [Application Power Management (APM)] .
8	TscInvariant: TSC invariant . Value: 1. The TSC rate is invariant.
7	HwpPstate: hardware P-state control . Value: 1. MSRC001_0061 [P-state Current Limit], MSRC001_0062 [P-state Control] and MSRC001_0063 [P-state Status] exist.
6	100MHzSteps: 100 MHz multiplier Control . Value: 1.
5	Reserved.
4	TM: hardware thermal control (HTC) . Value: Product-specific.
3	TTP: THERMTRIP . Value: 1.
2	VID: Voltage ID control . Value: 0. Function replaced by HwpPstate.
1	FID: Frequency ID control . Value: 0. Function replaced by HwpPstate.
0	TS: Temperature sensor . Value: 1.

CPUID Fn8000_0008_EAX Long Mode Address Size Identifiers

This provides information about the maximum physical and linear address width supported by the processor.

Bits	Description
31:24	Reserved.
23:16	GuestPhysAddrSize: maximum guest physical byte address size in bits . Value: 0. 0=The maximum guest physical address size defined by PhysAddrSize.

15:8	LinAddrSize: Maximum linear byte address size in bits. Value: IF (CUID Fn8000_0001_EDX[LM]) THEN 30h ELSE 20h ENDIF.
7:0	PhysAddrSize: Maximum physical byte address size in bits. Value: 28h.

CUID Fn8000_0008_EBX Reserved

Bits	Description
31:0	Reserved.

CUID Fn8000_0008_ECX Size Identifiers

This provides information about the number of cores supported by the processor.

Bits	Description										
31:18	Reserved.										
17:16	PerfTscSize: performance time-stamp counter size. Value: 00b. Indicates the size of MSRC001_0280[PTSC]. Valid only when (CUID Fn8000_0001_ECX[PerfTsc]==1). <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>40 bits</td></tr> <tr> <td>01b</td><td>48 bits</td></tr> <tr> <td>10b</td><td>56 bits</td></tr> <tr> <td>11b</td><td>64 bits</td></tr> </table>	Bits	Description	00b	40 bits	01b	48 bits	10b	56 bits	11b	64 bits
Bits	Description										
00b	40 bits										
01b	48 bits										
10b	56 bits										
11b	64 bits										
15:12	ApicIdCoreIdSize: APIC ID size. Value: 3h. The number of bits in the initial APIC20[ApicId] value that indicate core ID within a processor.										
11:8	Reserved.										
7:0	NC: number of cores - 1. Value: D18F5x84[CmpCap]-COUNT(D18F3x190[DisCore]). The number of cores in the processor is NC+1 (e.g., if NC=0, then there is one core). See 2.4.4 [Processor Cores and Downcoring].										

CUID Fn8000_0008_EDX Reserved

Bits	Description
31:0	Reserved.

CUID Fn8000_0009 Reserved

Bits	Description
31:0	Reserved.

CPUID Fn8000_000A_EAX SVM Revision and Feature Identification

This provides SVM revision. If (CPUID Fn8000_0001_ECX[SVM]==0) then CPUID Fn8000_000A_EAX is reserved.

Bits	Description
31:8	Reserved.
7:0	SvmRev: SVM revision. Value: 01h.

CPUID Fn8000_000A_EBX SVM Revision and Feature Identification

This provides SVM revision and feature information. If (CPUID Fn8000_0001_ECX[SVM]==0) then CPUID Fn8000_000A_EBX is reserved.

Bits	Description
31:0	NASID: number of address space identifiers (ASID). Value: 8h.

CPUID Fn8000_000A_ECX SVM Revision and Feature Identification

Bits	Description
31:0	Reserved.

CPUID Fn8000_000A_EDX SVM Revision and Feature Identification

This provides SVM feature information. If (CPUID Fn8000_0001_ECX[SVM]==0) then CPUID Fn8000_000A_EDX is reserved.

Bits	Description
31:14	Reserved.
13	AVIC: AMD virtual interrupt controller. Value: 0. 1=Support indicated for SVM mode virtualized interrupt controller; Indicates support for MSRC001_011B [AVIC Doorbell].
12	PauseFilterThreshold: PAUSE filter threshold. Value: 1.
11	Reserved.
10	PauseFilter: pause intercept filter. Value: 1.
9:8	Reserved.
7	DecodeAssists: decode assists. Value: 1.
6	FlushByAsid: flush by ASID. Value: 1.
5	VmcbClean: VMCB clean bits. Value: 0.

4	TscRateMsr: MSR based TSC rate control. Value: 1. 1=Indicates support for TSC ratio MSRC000_0104 .
3	NRIPS: NRIP Save. Value: 1.
2	SVML: SVM lock. Value: 1.
1	LbrVirt: LBR virtualization. Value: 1.
0	NP: nested paging. Value: 1.

CPUID Fn8000_00[18:0B] Reserved

Bits	Description
31:0	Reserved.

CPUID Fn8000_0019_EAX L1 TLB 1G Identifiers

This function provides first level TLB characteristics for 1G pages shared by each core on a L2 complex.

Bits	Description
31:28	L1DTlb1GAssoc: L1 data TLB associativity for 1 GB pages. See: CPUID Fn8000_0006_ECX [L2Assoc]. Value: 0.
27:16	L1DTlb1GSize: L1 data TLB number of entries for 1 GB pages. Value: 0.
15:12	L1ITlb1GAssoc: L1 instruction TLB associativity for 1 GB pages. See: CPUID Fn8000_0006_ECX [L2Assoc]. Value: 0.
11:0	L1ITlb1GSize: L1 instruction TLB number of entries for 1 GB pages. Value: 0.

CPUID Fn8000_0019_EBX L2 TLB 1G Identifiers

This provides 1 GB paging information. The *associativity* fields are defined by [CPUID Fn8000_0006_EAX](#), [CPUID Fn8000_0006_EBX](#), [CPUID Fn8000_0006_ECX](#) and [CPUID Fn8000_0006_EDX](#).

Bits	Description
31:28	L2DTlb1GAssoc: L2 data TLB associativity for 1 GB pages. See: CPUID Fn8000_0006_ECX [L2Assoc]. Value: 0.
27:16	L2DTlb1GSize: L2 data TLB number of entries for 1 GB pages. Value: 0.

15:12	L2ITlb1GAssoc: L2 instruction TLB associativity for 1 GB pages. See: CPUID Fn8000_0006_ECX [L2Assoc]. Value: 0.
11:0	L2ITlb1GSize: L2 instruction TLB number of entries for 1 GB pages. Value: 0.

CPUID Fn8000_0019_E[D,C]X Reserved

Bits	Description
31:0	Reserved.

CPUID Fn8000_001A_EAX Performance Optimization Identifiers

This function returns performance related information. For more details on how to use these bits to optimize software, see the optimization guide.

Bits	Description
31:3	Reserved.
2	FP256. Value: 0.
1	MOVU. Value: 1.
0	FP128. Value: 1.

CPUID Fn8000_001A_E[D,C,B]X Reserved

Bits	Description
31:0	Reserved.

CPUID Fn8000_001B_EAX Instruction Based Sampling Identifiers

This function returns IBS feature information.

Bits	Description
31:11	Reserved.
10	IbsOpData4: IBS op data 4 MSR supported. Value: 0. See MSRC001_103D [IBS Op Data 4 (DC_IBS_DATA2)].
9	IbsFetchCtlExtd: IBS fetch control extended MSR supported. Value: 0. 1=Indicates support for MSRC001_103C [IBS Fetch Control Extended (IC_IBS_EXTD_CTL)].

8	OpBrnFuse: fused branch micro-op indication supported. Value: 0. 1=Indicates support for MSRC001_1035 [IbsOpBrnFuse].
7	RipInvalidChk: invalid RIP indication supported. Value: 1. 1=Indicates support for MSRC001_1035 [IbsRipInvalid].
6	OpCntExt: IbsOpCurCnt and IbsOpMaxCnt extend by 7 bits. Value: 1. 1=Indicates support for MSRC001_1033 [IbsOpCurCnt[26:20], IbsOpMaxCnt[26:20]].
5	BrnTrgt: branch target address reporting supported. Value: 1.
4	OpCnt: op counting mode supported. Value: 1.
3	RdWrOpCnt: read write of op counter supported. Value: 1.
2	OpSam: IBS execution sampling supported. Value: 1.
1	FetchSam: IBS fetch sampling supported. Value: 1.
0	IBSFFV: IBS feature flags valid. Value: 1.

CPUID Fn8000_001B_E[D,C,B]X Instruction Based Sampling Identifiers

Bits	Description
31:0	Reserved.

CPUID Fn8000_001C_EAX Lightweight Profiling Capabilities 0

This function returns IBS feature information; see the Lightweight Profiling Specification section titled “Detecting LWP”. If ([CPUID Fn8000_0001_ECX](#)[LWP]==0) then CPUID Fn8000_001C_E[D,C,B,A]X is reserved.

Bits	Description
31:0	Reserved.

CPUID Fn8000_001C_EBX Lightweight Profiling Capabilities 0

See [CPUID Fn8000_001C_EAX](#).

Bits	Description
31:0	Reserved.

CPUID Fn8000_001C_ECX Lightweight Profiling Capabilities 0

See [CPUID Fn8000_001C_EAX](#).

Bits	Description
31:0	Reserved.

CPUID Fn8000_001C_EDX Lightweight Profiling Capabilities 0

See [CPUID Fn8000_001C_EAX](#).

Bits	Description
31:0	Reserved.

CPUID Fn8000_001D_EAX_x0 Cache Properties

CPUID Fn8000_001D_EAX_x0 reports topology information for the DC.

If (CPUID Fn8000_0001_ECX[TopologyExtensions]==0) then CPUID Fn8000_001D_E[D,C,B,A]X is reserved.

Table 214: ECX mapping to Cache Type for CPUID Fn8000_001D_E[D,C,B,A]X

ECX	Cache Type
0	DC
1	IC
2	L2
3	Null

Bits	Description												
31:26	Reserved.												
25:14	NumSharingCache: number of cores sharing cache. Value: 000h. The number of cores sharing this cache is NumSharingCache+1.												
13:10	Reserved.												
9	FullyAssociative: fully associative cache. Value: 0. 1=Cache is fully associative.												
8	SelfInitialization: cache is self-initializing. Value: 1. 1=Cache is self initializing; cache does not need software initialization.												
7:5	CacheLevel: cache level. Identifies the cache level. Value: 001b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Reserved.</td></tr> <tr> <td>001b</td><td>Level 1</td></tr> <tr> <td>010b</td><td>Level 2</td></tr> <tr> <td>011b</td><td>Level 3</td></tr> <tr> <td>111b-100b</td><td>Reserved.</td></tr> </table>	Bits	Description	000b	Reserved.	001b	Level 1	010b	Level 2	011b	Level 3	111b-100b	Reserved.
Bits	Description												
000b	Reserved.												
001b	Level 1												
010b	Level 2												
011b	Level 3												
111b-100b	Reserved.												
4:0	CacheType: cache type. Identifies the type of cache. Value: 01h. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Null; no more caches.</td></tr> <tr> <td>01h</td><td>Data cache</td></tr> <tr> <td>02h</td><td>Instruction cache</td></tr> <tr> <td>03h</td><td>Unified cache</td></tr> <tr> <td>1Fh-04h</td><td>Reserved.</td></tr> </table>	Bits	Description	00h	Null; no more caches.	01h	Data cache	02h	Instruction cache	03h	Unified cache	1Fh-04h	Reserved.
Bits	Description												
00h	Null; no more caches.												
01h	Data cache												
02h	Instruction cache												
03h	Unified cache												
1Fh-04h	Reserved.												

CPUID Fn8000_001D_EAX_x1 Cache Properties

CPUID Fn8000_001D_EAX_x1 reports topology information for the IC. See CPUID Fn8000_001D_EAX_x0.

Bits	Description
31:26	Reserved.
25:14	NumSharingCache: number of cores sharing cache. See: CPUID Fn8000_001D_EAX_x0[NumSharingCache] . Value: 000h.
13:10	Reserved.
9	FullyAssociative: fully associative cache. Value: 0. See: CPUID Fn8000_001D_EAX_x0[FullyAssociative] .
8	SelfInitialization: cache is self-initializing. Value: 1. See: CPUID Fn8000_001D_EAX_x0[SelfInitialization] .
7:5	CacheLevel: cache level. Identifies the cache level. Value: 001b. See: CPUID Fn8000_001D_EAX_x0[CacheLevel] .
4:0	CacheType: cache type. Value: 02h. See: CPUID Fn8000_001D_EAX_x0[CacheType] .

CPUID Fn8000_001D_EAX_x2 Cache Properties

[CPUID Fn8000_001D_EAX_x2](#) reports topology information for the L2. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:26	Reserved.
25:14	NumSharingCache: number of cores sharing cache. See: CPUID Fn8000_001D_EAX_x0[NumSharingCache] . Value: CPUID Fn8000_001E_EBX[ThreadsPerComputeUnit] .
13:10	Reserved.
9	FullyAssociative: fully associative cache. Value: 0. See: CPUID Fn8000_001D_EAX_x0[FullyAssociative] .
8	SelfInitialization: cache is self-initializing. Value: 1. See: CPUID Fn8000_001D_EAX_x0[SelfInitialization] .
7:5	CacheLevel: cache level. Identifies the cache level. Value: 010b. See: CPUID Fn8000_001D_EAX_x0[CacheLevel] .
4:0	CacheType: cache type. Value: 03h. See: CPUID Fn8000_001D_EAX_x0[CacheType] .

CPUID Fn8000_001D_EAX_x3 Cache Properties

[CPUID Fn8000_001D_EAX_x3](#) reports done/null. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:5	Reserved.
4:0	CacheType: cache type. Value: 00h. See: CPUID Fn8000_001D_EAX_x0[CacheType] .

CPUID Fn8000_001D_EBX_x0 Cache Properties

CPUID Fn8000_001D_EBX_x0 reports topology information for the DC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:22	CacheNumWays: cache number of ways. Cache number of ways is CacheNumWays+1. Value: 007h.
21:12	CachePhysPartitions: cache physical line partitions. Value: 000h. Cache partitions is CachePhysPartitions+1.
11:0	CacheLineSize: cache line size in bytes. Value: 03Fh. Cache line size in bytes is CacheLineSize+1.

CPUID Fn8000_001D_EBX_x1 Cache Properties

CPUID Fn8000_001D_EBX_x1 reports topology information for the IC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:22	CacheNumWays: cache number of ways. See: CPUID Fn8000_001D_EBX_x0 [CacheNumWays]. Value: 001h.
21:12	CachePhysPartitions: cache physical line partitions. Value: 000h. See: CPUID Fn8000_001D_EBX_x0 [CachePhysPartitions].
11:0	CacheLineSize: cache line size in bytes. Value: 03Fh. See: CPUID Fn8000_001D_EBX_x0 [CacheLineSize].

CPUID Fn8000_001D_EBX_x2 Cache Properties

CPUID Fn8000_001D_EBX_x2 reports topology information for the L2. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:22	CacheNumWays: cache number of ways. Value: 00Fh. See: CPUID Fn8000_001D_EBX_x0 [CacheNumWays].
21:12	CachePhysPartitions: cache physical line partitions. Value: 000h. See: CPUID Fn8000_001D_EBX_x0 [CachePhysPartitions].
11:0	CacheLineSize: cache line size in bytes. Value: 03Fh. See: CPUID Fn8000_001D_EBX_x0 [CacheLineSize].

CPUID Fn8000_001D_EBX_x3 Cache Properties

CPUID Fn8000_001D_EAX_x3 reports done/null. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:22	CacheNumWays: cache number of ways. Value: 0. See: CPUID Fn8000_001D_EBX_x0 [CacheNumWays].
21:12	CachePhysPartitions: cache physical line partitions. Value: 000h. See: CPUID Fn8000_001D_EBX_x0 [CachePhysPartitions].
11:0	CacheLineSize: cache line size in bytes. Value: 0. See: CPUID Fn8000_001D_EBX_x0 [CacheLineSize].

CPUID Fn8000_001D_ECX_x0 Cache Properties

[CPUID Fn8000_001D_ECX_x0](#) reports topology information for the DC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:0	CacheNumSets: cache number of sets. Cache number of sets is CacheNumSets+1. Value: 0000_003Fh.

CPUID Fn8000_001D_ECX_x1 Cache Properties

[CPUID Fn8000_001D_ECX_x1](#) reports topology information for the IC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:0	CacheNumSets: cache number of sets. See: CPUID Fn8000_001D_ECX_x0 [CacheNumSets]. Value: 0000_00FFh.

CPUID Fn8000_001D_ECX_x2 Cache Properties

[CPUID Fn8000_001D_ECX_x2](#) reports topology information for the L2. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:0	CacheNumSets: cache number of sets. Value: Product-specific. See: CPUID Fn8000_001D_ECX_x0 [CacheNumSets].

CPUID Fn8000_001D_ECX_x3 Cache Properties

[CPUID Fn8000_001D_EAX_x3](#) reports done/null. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:0	Reserved. Value: 0000_0000h.

CPUID Fn8000_001D_EDX_x0 Cache Properties

[CPUID Fn8000_001D_EDX_x0](#) reports topology information for the DC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:2	Reserved.
1	CacheInclusive: cache inclusive. Value: 0. 0=Cache is not inclusive of lower cache levels. 1=Cache is inclusive of lower cache levels.
0	WBINVD: Write-Back Invalidate/Invalidate. Value: 0. 0=WBINVD/INVD invalidates all lower level caches of non-originating cores sharing this cache. 1=WBINVD/INVD not ensured to invalidate all lower level caches of non-originating cores sharing this cache.

CPUID Fn8000_001D_EDX_x1 Cache Properties

[CPUID Fn8000_001D_EDX_x1](#) reports topology information for the IC. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:2	Reserved.
1	CacheInclusive: cache inclusive. Value: 0. See: CPUID Fn8000_001D_EDX_x0[CacheInclusive] .
0	WBINVD: Write-Back Invalidate/Invalidate. Value: 0. See: CPUID Fn8000_001D_EDX_x0[WBINVD] .

CPUID Fn8000_001D_EDX_x2 Cache Properties

[CPUID Fn8000_001D_EDX_x2](#) reports topology information for the L2. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:2	Reserved.
1	CacheInclusive: cache inclusive. See: CPUID Fn8000_001D_EDX_x0[CacheInclusive] . Value: 1.
0	WBINVD: Write-Back Invalidate/Invalidate. Value: 0. See: CPUID Fn8000_001D_EDX_x0[WBINVD] .

CPUID Fn8000_001D_EDX_x3 Cache Properties

[CPUID Fn8000_001D_EAX_x3](#) reports done/null. See [CPUID Fn8000_001D_EAX_x0](#).

Bits	Description
31:0	Reserved. Value: 0000_0000h.

CPUID Fn8000_001E_EAX Extended APIC ID

If [CPUID Fn8000_0001_ECX](#)[TopologyExtensions]==0 then CPUID Fn8000_001E_E[D,C,B,A]X is reserved. If ([MSR0000_001B](#)[ApicEn]==0) then [CPUID Fn8000_001E_EAX](#)[ExtendedApicId] is reserved.

Bits	Description
31:0	ExtendedApicId: extended APIC ID. Value: IF (MSR0000_001B [ApicEn]==0) THEN 0000_0000h ELSE APIC20 [31:0] ENDIF.

CPUID Fn8000_001E_EBX Compute Unit Identifiers

See [CPUID Fn8000_001E_EAX](#).

Bits	Description
31:16	Reserved.
15:8	ThreadsPerComputeUnit: threads per compute unit. The number of threads per compute unit is ThreadsPerComputeUnit+1. Value: 0.
7:0	ComputeUnitId: compute unit ID. Identifies the processor compute unit ID. Value: Product-specific.

CPUID Fn8000_001E_ECX Node Identifiers

See [CPUID Fn8000_001E_EAX](#).

Bits	Description
31:0	Reserved.

CPUID Fn8000_001E_EDX Reserved

See [CPUID Fn8000_001E_EAX](#).

Bits	Description
31:0	Reserved.

3.19 MSRs - MSR0000_XXXX

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. MSRs are accessed through x86 WRMSR and RDMSR instructions.

MSR0000_0000 Load-Store MCA Address

Bits	Description
63:0	Alias of MSR0000_0402 .

MSR0000_0001 Load-Store MCA Status

Bits	Description
63:0	Alias of MSR0000_0401 .

MSR0000_0010 Time Stamp Counter (TSC)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:32	TSC[63:32]: time stamp counter high. See: TSC[31:0].
31:0	TSC[31:0]: time stamp counter low. Read-write; updated-by-hardware. TSC[63:0] = {TSC[63:32],TSC[31:0]}. The TSC increments at the P0 frequency. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering]. The TSC counts at the same rate in all P-states, all C states, S0, or S1. A read of this MSR in guest mode is affected by MSRC000_0104 [Time Stamp Counter Ratio (TscRateMsr)] . The value (TSC/TSCRatio) is the TSC P0 frequency based value (as if TSCRatio==1.0) when (TSCRatio!=1.0).

MSR0000_001B APIC Base Address (APIC_BAR)

Bits	Description
63:40	MBZ.
39:12	ApicBar[39:12]: APIC base address register. Read-write. Reset: 00_FEE0_0h. Specifies the base address, physical address [39:12], for the APICXX register set in xAPIC mode. See 2.4.8.1.2 [APIC Register Space].
11	ApicEn: APIC enable. Read-write. Reset: 0. See 2.4.8.1.2 [APIC Register Space]. 1=Local APIC is enabled in xAPIC mode.
10	MBZ.
9	MBZ.
8	BSC: boot strap core. Read-write; updated-by-hardware. Reset: x. 1=The core is the boot core of the BSP. 0=The core is not the boot core of the BSP.
7:0	MBZ.

MSR0000_002A Cluster ID (EBL_CR_POWERON)

Read; GP-write.

Bits	Description
63:18	MBZ.
17:16	ClusterID . Reset: 00b. The field does not affect hardware.
15:0	MBZ.

MSR0000_00E7 Max Performance Frequency Clock Count (MPERF)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	MPERF: maximum core clocks counter . Read-write; Updated-by-hardware . Incremented by hardware at the P0 frequency while the core is in C0. This register does not increment when the core is in the stop-grant state. In combination with MSR0000_00E8 , this is used to determine the effective frequency of the core. A read of this MSR in guest mode is affected by MSRC000_0104 [Time Stamp Counter Ratio (TscRateMsr)] . This field uses software P-state numbering. See MSRC001_0015[Eff-FreqCntMwait] , 2.5.3.3 [Effective Frequency] , and 2.5.3.1.1.1 [Software P-state Numbering] .

MSR0000_00E8 Actual Performance Frequency Clock Count (APERF)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	APERF: actual core clocks counter . Read-write; Updated-by-hardware . This register increments in proportion to the actual number of core clocks cycles while the core is in C0. The register does not increment when the core is in the stop-grant state. See MSR0000_00E7 .

MSR0000_00FE MTRR Capabilities (MTRRcap)

Read; GP-write. Reset: 0000_0000_0000_0508h.

Bits	Description
63:11	Reserved.
10	MtrrCapWc: write-combining memory type . 1=The write combining memory type is supported.
9	Reserved.
8	MtrrCapFix: fixed range register . 1=Fixed MTRRs are supported.
7:0	MtrrCapVCnt: variable range registers count . Specifies the number of variable MTRRs supported.

MSR0000_0174 SYSENTER CS (SYSENTER_CS)

Bits	Description
63:32	RAZ.

31:16	Reserved.
15:0	SysEnterCS: SYSENTER target CS. Read-write. Reset: 0000h. Holds the called procedure code segment.

MSR0000_0175 SYSENTER ESP (SYSENTER_ESP)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:32	Reserved.
31:0	SysEnterESP: SYSENTER target SP. Read-write. Holds the called procedure stack pointer.

MSR0000_0176 SYSENTER EIP (SYSENTER_EIP)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:32	Reserved.
31:0	SysEnterEIP: SYSENTER target IP. Read-write. Holds the called procedure instruction pointer.

MSR0000_0179 Global Machine Check Capabilities (MCG_CAP)

Read; GP-write.

Bits	Description
63:9	Reserved.
8	McgCtlP: MCG_CTL register present. Value: 1. 1=The machine check control registers (MCI_CTL) are present. See 2.16.1 [Machine Check Architecture]
7:0	Count. Value: 06h. Indicates the number of error reporting banks visible to each core. 06h=Error-reporting banks 0 through 5. See 2.16.1.1 [Machine Check Registers] .

MSR0000_017A Global Machine Check Status (MCG_STAT)

Reset: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#).

Bits	Description
63:3	Reserved.
2	MCIP: machine check in progress. Read-write; set-by-hardware. 1=A machine check is in progress.
1	EIPV: error instruction pointer valid. Read-write; Updated-by-hardware. 1=The instruction pointer that was pushed onto the stack by the machine check mechanism references the instruction that caused the machine check error.
0	RIPV: restart instruction pointer valid. Read-write; Updated-by-hardware. 1=Program execution can be reliably restarted at the EIP address on the stack. 0=The interrupt was not precise and/or the process (task) context may be corrupt; continued operation of this process may not be possible without intervention, however system processing or other processes may be able to continue with appropriate software clean up.

MSR0000_017B Global Machine Check Exception Reporting Control (MCG_CTL)

Read-write. Reset: 0000_0000_0000_0000h. This registers controls enablement of the individual error reporting banks; see 2.16.1 [Machine Check Architecture]. When a machine check register bank is not enabled in MCG_CTL, errors for that bank are not logged or reported, and actions enabled through the MCA are not taken; each MCI_CTL register identifies which errors are still corrected when MCG_CTL[i] is disabled.

Bits	Description
63:7	Unused.
6	Unused.
5	MC5En: MC5 register bank enable. 1=The MC5 machine check register bank is enabled.
4	MC4En: MC4 register bank enable. 1=The MC4 machine check register bank is enabled for all cores of the node.
3	Unused.
2	MC2En: MC2 register bank enable. 1=The MC2 machine check register bank is enabled.
1	MC1En: MC1 register bank enable. 1=The MC1 machine check register bank is enabled.
0	MC0En: MC0 register bank enable. 1=The MC0 machine check register bank is enabled.

MSR0000_01D9 Debug Control (DBG_CTL_MSR)

Bits	Description
63:7	Reserved.
6	MBZ.
5:2	PB: performance monitor pin control. Read-write. Reset: 0. This field does not control any hardware.
1	BTF. Read-write. Reset: 0. 1=Enable branch single step.
0	LBR. Read-write. Reset: 0. 1=Enable last branch record.

MSR0000_01DB Last Branch From IP (BR_FROM)

Read; GP-write; *Not-same-for-all*, *Updated-by-hardware*. Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	LastBranchFromIP. Loaded with the segment offset of the branch instruction.

MSR0000_01DC Last Branch To IP (BR_TO)

Read; GP-write; *Not-same-for-all*, *Updated-by-hardware*. Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	LastBranchToIP. Holds the target RIP of the last branch that occurred before an exception or interrupt.

MSR0000_01DD Last Exception From IP

Read; GP-write; [Not-same-for-all](#), [Updated-by-hardware](#). Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	LastIntFromIP. Holds the source RIP of the last branch that occurred before the exception or interrupt.

MSR0000_01DE Last Exception To IP

Read; GP-write; [Not-same-for-all](#), [Updated-by-hardware](#). Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	LastIntToIP. Holds the target RIP of the last branch that occurred before the exception or interrupt.

MSR0000_020[F:0] Variable-Size MTRRs Base/Mask

Each MTRR ([MSR0000_020\[F:0\] \[Variable-Size MTRRs Base/Mask\]](#), [MSR0000_02\[6F:68,59:58,50\]](#), or [MSR0000_02FF \[MTRR Default Memory Type \(MTRRdefType\)\]](#)) specifies a physical address range and a corresponding memory type (MemType) associated with that range. Setting the memory type to an unsupported value results in a #GP.

The variable-size MTRRs come in pairs of base and mask registers (MSR0000_0200 and MSR0000_0201 are the first pair, etc.). Variables MTRRs are enabled through [MSR0000_02FF\[MtrrDefTypeEn\]](#). A core access--with address CPUAddr--is determined to be within the address range of a variable-size MTRR if the following equation is true:

$\text{CPUAddr}[39:12] \& \text{PhyMask}[39:12] == \text{PhyBase}[39:12] \& \text{PhyMask}[39:12]$.

For example, if the variable MTRR spans 256 KB and starts at the 1 MB address. The PhyBase would be set to 0_0010_0000h and the PhyMask to F_FFFC_0000h (with zeros filling in for bits[11:0]). This results in a range from 0_0010_0000h to 0_0013_FFFF.

MSR0000_020[E,C,A,8,6,4,2,0] Variable-Size MTRRs Base

Table 215: [Register Mapping](#) for [MSR0000_020\[E,C,A,8,6,4,2,0\]](#)

Register	Function
MSR0000_0200	Range 0
MSR0000_0202	Range 1
MSR0000_0204	Range 2
MSR0000_0206	Range 3
MSR0000_0208	Range 4
MSR0000_020A	Range 5
MSR0000_020C	Range 6
MSR0000_020E	Range 7

Table 216: Valid Values for Memory Type Definition

Bits	Description
000b	UC or uncacheable.
001b	WC or write combining.
011b-010b	Reserved
100b	WT or write through.
101b	WP or write protect.
110b	WB or write back.
111b	Reserved

Bits	Description
63:40	MBZ.
39:12	PhyBase: base address. Read-write. Reset: 0.
11:3	MBZ.
2:0	MemType: memory type. Read-write. Reset: 0. Address range from 00000h to 0FFFFh. See: Table 216 [Valid Values for Memory Type Definition] .

MSR0000_020[F,D,B,9,7,5,3,1] Variable-Size MTRRs MaskTable 217: [Register Mapping](#) for [MSR0000_020\[F,D,B,9,7,5,3,1\]](#)

Register	Function
MSR0000_0201	Range 0
MSR0000_0203	Range 1
MSR0000_0205	Range 2
MSR0000_0207	Range 3
MSR0000_0209	Range 4
MSR0000_020B	Range 5
MSR0000_020D	Range 6
MSR0000_020F	Range 7

Bits	Description
63:40	MBZ.
39:12	PhyMask: address mask. Read-write. Reset: 0.
11	Valid: valid. Read-write. Reset: 0. 1=The variable-size MTRR pair is enabled.
10:0	MBZ.

MSR0000_02[6F:68,59:58,50] Fixed-Size MTRRs

See [MSR0000_020\[F:0\]](#) for general MTRR information. Fixed MTRRs are enabled through [MSR0000_02FF](#)[MtrrDefTypeFixEn, MtrrDefTypeEn]. For addresses below 1MB, the appropriate Fixed MTRRs override the default access destination. Each fixed MTRR includes two bits, RdDram and WrDram,

that determine the destination based on the access type.
See 2.4.6.1.2 [Determining The Access Destination for Core Accesses].

Table 218: Register Mapping for MSR0000_02[6F:68,59:58,50]

Register	Function
MSR0000_0250	64K Range
MSR0000_0258	16K_0 Range
MSR0000_0259	16K_1 Range
MSR0000_0268	4K_0 Range
MSR0000_0269	4K_1 Range
MSR0000_026A	4K_2 Range
MSR0000_026B	4K_3 Range
MSR0000_026C	4K_4 Range
MSR0000_026D	4K_5 Range
MSR0000_026E	4K_6 Range
MSR0000_026F	4K_7 Range

Table 219: Field Mapping for MSR0000_02[6F:68,59:58,50]

Register	Bits							
	63:56	55:48	47:40	39:32	31:24	23:16	15:8	7:0
MSR0000_0250	64K_70000	64K_60000	64K_50000	64K_40000	64K_30000	64K_20000	64K_10000	64K_00000
MSR0000_0258	16K_9C000	16K_98000	16K_94000	16K_90000	16K_8C000	16K_88000	16K_84000	16K_80000
MSR0000_0259	16K_BC000	16K_B8000	16K_B4000	16K_B0000	16K_AC000	16K_A8000	16K_A4000	16K_A0000
MSR0000_0268	4K_C7000	4K_C6000	4K_C5000	4K_C4000	4K_C3000	4K_C2000	4K_C1000	4K_C0000
MSR0000_0269	4K_CF000	4K_CE000	4K_CD000	4K_CC000	4K_CB000	4K_CA000	4K_C9000	4K_C8000
MSR0000_026A	4K_D7000	4K_D6000	4K_D5000	4K_D4000	4K_D3000	4K_D2000	4K_D1000	4K_D0000
MSR0000_026B	4K_DF000	4K_DE000	4K_DD000	4K_DC000	4K_DB000	4K_DA000	4K_D9000	4K_D8000
MSR0000_026C	4K_E7000	4K_E6000	4K_E5000	4K_E4000	4K_E3000	4K_E2000	4K_E1000	4K_E0000
MSR0000_026D	4K_EF000	4K_EE000	4K_ED000	4K_EC000	4K_EB000	4K_EA000	4K_E9000	4K_E8000
MSR0000_026E	4K_F7000	4K_F6000	4K_F5000	4K_F4000	4K_F3000	4K_F2000	4K_F1000	4K_F0000
MSR0000_026F	4K_FF000	4K_FE000	4K_FD000	4K_FC000	4K_FB000	4K_FA000	4K_F9000	4K_F8000

Bits	Description
63:61	MBZ.
60	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4].
59	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3].
58:56	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0].
55:53	MBZ.
52	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4].
51	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3].
50:48	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0].
47:45	MBZ.

44	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4] .
43	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3] .
42:40	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0] .
39:37	MBZ.
36	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4] .
35	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3] .
34:32	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0] .
31:29	MBZ.
28	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4] .
27	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3] .
26:24	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0] .
23:21	MBZ.
20	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4] .
19	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3] .
18:16	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0] .
15:13	MBZ.
12	RdDram: read DRAM. See: MSR0000_02[6F:68,59:58,50][4] .
11	WrDram: write DRAM. See: MSR0000_02[6F:68,59:58,50][3] .
10:8	MemType: memory type. See: MSR0000_02[6F:68,59:58,50][2:0] .
7:5	MBZ.
4	RdDram: read DRAM. IF (MSRC001_0010[MtrrFixDramModEn]) THEN Read-write. ELSE MBZ. ENDIF. Reset: 0. 0=Read accesses to the range are marked as MMIO. 1=Read accesses to the range are marked as destined for DRAM. Address range from 00000h to 0FFFFh. See: MSRC001_0010[MtrrFixDramEn, MtrrFixDramModEn] .
3	WrDram: write DRAM. IF (MSRC001_0010[MtrrFixDramModEn]) THEN Read-write. ELSE MBZ. ENDIF. Reset: 0. 0=Write accesses to the range are marked as MMIO. 1=Write accesses to the range are marked as destined for DRAM. Address range from 00000h to 0FFFFh. See: MSRC001_0010[MtrrFixDramEn, MtrrFixDramModEn] .
2:0	MemType: memory type. Read-write. Reset: 0. Address range from 00000h to 0FFFFh. See: Table 216 [Valid Values for Memory Type Definition] .

MSR0000_0277 Page Attribute Table (PAT)

This register specifies the memory type based on the PAT, PCD, and PWT bits in the virtual address page tables.

Bits	Description
63:59	MBZ.
58:56	PA7MemType. See: PA0MemType. Reset: 0h. Default UC. MemType for {PAT, PCD, PWT} = 7h.
55:51	MBZ.
50:48	PA6MemType. See: PA0MemType. Reset: 7h. Default UC-. MemType for {PAT, PCD, PWT} = 6h.
47:43	MBZ.

42:40	PA5MemType. See: PA0MemType. Reset: 4h. Default WT. MemType for {PAT, PCD, PWT} = 5h.			
39:35	MBZ.			
34:32	PA4MemType. See: PA0MemType. Reset: 6h. Default WB. MemType for {PAT, PCD, PWT} = 4h.			
31:27	MBZ.			
26:24	PA3MemType. See: PA0MemType. Reset: 0h. Default UC. MemType for {PAT, PCD, PWT} = 3h.			
23:19	MBZ.			
18:16	PA2MemType. See: PA0MemType. Reset: 7h. Default UC-. MemType for {PAT, PCD, PWT} = 2h.			
15:11	MBZ.			
10:8	PA1MemType. See: PA0MemType. Reset: 4h. Default WT. MemType for {PAT, PCD, PWT} = 1h.			
7:3	MBZ.			
2:0	PA0MemType. Read-write. Reset: 6h. MemType for {PAT, PCD, PWT} = 0h.			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	0h	UC or uncacheable.	4h	WT or write through.
	1h	WC or write combining.	5h	WP or write protect.
	2h	MBZ.	6h	WB or write back.
	3h	MBZ.	7h	UC- or uncacheable (overridden by WC state).

MSR0000_02FF MTRR Default Memory Type (MTRRdefType)

See [MSR0000_020\[F:0\]](#) for general MTRR information.

Bits	Description
63:12	MBZ.
11	MtrrDefTypeEn: variable and fixed MTRR enable . Read-write. Reset: 0. 1= MSR0000_020[F:0] [Variable-Size MTRRs Base/Mask], and MSR0000_02[6F:68,59:58,50] [Fixed-Size MTRRs] are enabled. 0=Fixed and variable MTRRs are not enabled.
10	MtrrDefTypeFixEn: fixed MTRR enable . Read-write. Reset: 0. 1= MSR0000_02[6F:68,59:58,50] [Fixed-Size MTRRs] are enabled. This field is ignored (and the fixed MTRRs are not enabled) if MSR0000_02FF [MtrrDefTypeEn]=0.
9:8	MBZ.
7:0	MemType: memory type . Read-write. Reset: 0. If MtrrDefTypeEn==1 then MemType specifies the memory type for memory space that is not specified by either the fixed or variable range MTRRs. If MtrrDefTypeEn==0 then the default memory type for all of memory is UC. Valid encodings are {00000b, MSR0000_02[6F:68,59:58,50][2:0] }.

MSR0000_0400 MC0 Machine Check Control (MC0_CTL)

Read-write. Reset: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). See [MSRC001_0044 \[DC Machine Check Control Mask \(MC0_CTL_MASK\)\]](#)

Bits	Description
63:12	Unused.
11	SRDE_ALL: all system read data errors . Report system read data errors for any operation including a DC/IC fetch, or TLB reload.

10	SRDET: read data errors on TLB reload. Report system read data errors on a TLB reload if MSR0000_0400 [SRDE_ALL] = 1.
9	SRDES: read data errors on store. Report system read data errors on a store if MSR0000_0400 [SRDE_ALL] = 1.
8	SRDEL: read data errors on load. Report system read data errors on a load if MSR0000_0400 [SRDE_ALL] = 1.
7	TLB2M: L2DTLB multi-hit errors. Report L2DTLB multi-hit errors.
6	TLB2P: L2DTLB parity errors. Report TLB parity and multimatch errors.
5	TLB1M: L1DTLB multi-hit errors. Report L1DTLB multi-hit errors.
4	Unused.
3	DTP: tag array parity errors. Report data cache tag array parity errors.
2	DDP: data array parity errors. Report data cache data array parity errors.
1:0	Unused.

MSR0000_0401 MC0 Machine Check Status (MC0_STATUS)

See 2.16.1 [Machine Check Architecture]. See [MSRC001_0015](#)[McStatusWrEn]. Table 221 describes the error codes and status register settings for each error type. [MSR0000_0001](#) is an alias of [MSR0000_0401](#).

Bits	Description
63	Val: error valid. Read-write; set-by-hardware. Cold reset: 0. 1=This bit indicates that a valid error has been detected. This bit should be cleared to 0 by software after the register has been read.
62	<p>Overflow: error overflow. Read-write; set-by-hardware. Cold reset: 0. 1=An error was detected while the valid bit (Val) was set; at least one error was not logged. Overflow is set independently of whether the existing error is overwritten.</p> <p>The following hierarchy identifies the error logging priorities.</p> <ol style="list-style-type: none"> 1. Uncorrectable errors 2. Correctable errors <p>The machine check mechanism handles the contents of MCi_STATUS during overflow as follows:</p> <ul style="list-style-type: none"> • Higher priority errors overwrite lower priority errors. • New errors of equal or lower priority do not overwrite existing errors. • Uncorrectable errors which are not logged due to overflow result in setting PCC, unless the new uncorrectable error is of the same type and in the same reportable address range as the existing error.
61	UC: error uncorrected. Read-write; Updated-by-hardware. Cold reset: 0. 1=The error was not corrected by hardware.
60	En: error enable. Read-write; Updated-by-hardware. Cold reset: 0. 1=MCA error reporting is enabled for this error, as indicated by MCi_CTL.
59	<p>MiscV: miscellaneous error register valid.</p> <p>Value: 0. 1=Valid thresholding in MSR0000_0403.</p>

58	AddrV: error address valid. Read-write; Updated-by-hardware. Cold reset: 0. 1=MCi_ADDR contains address information associated with the error.																				
57	PCC: processor context corrupt. Read-write; Updated-by-hardware. Cold reset: 0. 1=Hardware context held by the processor may have been corrupted. Continued operation of the system may have unpredictable results. The error is not recoverable or survivable, and the system should be reinitialized. See 2.16.1.6.1 [Differentiation Between System-Fatal and Process-Fatal Errors] .																				
56:45	Reserved.																				
44	Deferred: deferred error. Value: 0. 1=A deferred error was created. A deferred error is the result of an uncorrectable data error which did not immediately cause a processor exception; the data is poisoned and an exception is deferred until the data is loaded by a core.																				
43	Poison: poison error. Value: 0. 1=The error was the result of attempting to consume poisoned data. This indicator does not apply to MSR0000_0411 [MC4 Machine Check Status (MC4_STATUS)] .																				
42:40	Reserved.																				
39	Reserved.																				
38:36	Way: cache way in error. Read-write; Updated-by-hardware.Cold reset: 0. Indicates the cache way for parity error only. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>0h</td><td>Way 0</td><td>4h</td><td>Way 4</td></tr><tr><td>1h</td><td>Way 1</td><td>5h</td><td>Way 5</td></tr><tr><td>2h</td><td>Way 2</td><td>6h</td><td>Way 6</td></tr><tr><td>3h</td><td>Way 3</td><td>7h</td><td>Way 7</td></tr></table>	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>	0h	Way 0	4h	Way 4	1h	Way 1	5h	Way 5	2h	Way 2	6h	Way 6	3h	Way 3	7h	Way 7
<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>																		
0h	Way 0	4h	Way 4																		
1h	Way 1	5h	Way 5																		
2h	Way 2	6h	Way 6																		
3h	Way 3	7h	Way 7																		
35:21	Reserved.																				
20:16	ErrorCodeExt: extended error code. Read-write; Updated-by-hardware. Cold reset: 0. Logs an extended error code when an error is detected. This model-specific field is used in conjunction with ErrorCode to identify the error sub-type for root cause analysis (see 2.16.1.5 [Error Code]). See Table 221 for expected values.																				
15:0	ErrorCode: error code. Read-write; Updated-by-hardware. Cold reset: 0. See 2.16.1.5 [Error Code] for details on decoding this field. See Table 221 for expected values.																				

Table 220: MC0 Error Descriptions

Error Type	Error Sub-type	Description ¹	CTL ²	EAC ³
Data Parity		A DC data parity error for a tag hit occurred during an LS access to the DC.	DDP	E
Tag Parity		A DC tag array parity error for a data hit occurred during an LS access to the DC.	DTP	E
Copyback Parity		A DC data or tag array parity error for a tag miss occurred during an LS access to the DC.	DDP, DTP	E

Table 220: MC0 Error Descriptions

Error Type	Error Sub-type	Description ¹	CTL ²	EAC ³
Tag Snoop Parity		A tag parity error was encountered during snoop. Data array parity check enabled only for tag hit.	DDP, DTP	E
L2 TLB Error	TLB parity	Parity error in BTLB. Regardless of whether this error is masked from logging, it will invalidate the lookup index (for both 4k and 2M storage) where the error occurred and an L2DTLB miss will be generated.	TLB2P	E
L1 TLB Error	TLB multimatch	Hit multiple entries. Regardless of whether this error is masked from logging or enabled for SyncFlood generation, the L1DTLB will be flushed.	TLB1M	E
L2 TLB Error	TLB multimatch	Hit multiple entries. Regardless of whether this error is masked from logging, it will invalidate the lookup index (for both 4k and 2M storage) where the error occurred and an L2DTLB miss will be generated.	TLB2M	E
System Read Data Error	TLB Reload	System read data error occurred on a TLB reload.	SRDET	E
	Store	System read data error occurred on a store.	SRDES	E
	Load	System read data error occurred on a load .	SRDEL	E
1. CID: core ID. All LS errors are reported to the affected core; see 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. 2. See MSR0000_0400. 3. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See 2.16.1.3 [Error Detection, Action, Logging, and Reporting].				

Table 221: MC0 Error Signatures

Error Type	Error	ErrorCodeExt	Error Code						UC	ADDRV	PCC
			Type	UU/P P	T	RRRR	II/TT	LL			
Data Parity	Load,	0h	MEM	-	-	DRD	Data	L1	1	1	0
	Store	0h		-	-	DWR	Data	L1	1	1	1
Tag Parity	Load,	10h		-	-	DRD	Data	L1	1	1	1
	Store	10h		-	-	DWR	Data	L1	1	1	1
Copyback Parity	-	0h		-	-	Evict	Data	L1	1	1	1
Tag Snoop Parity	-	10h		-	-	Snoop	Data	L1	1	1	1
L2DTLB Parity	-	0h	TLB	-	-	-	Data	L2	0	1	0
L1DTLB Multimatch	-	1h		-	-	-	Data	L1	0 ¹	1	0 ¹
L2DTLB Multimatch	-	1h		-	-	-	Data	L2	0	1	0

Table 221: MC0 Error Signatures

Error Type	Error	ErrorCod eExt	Error Code						UC	ADDRV	PCC
			Type	UU/P P	T	RRRR	II/TT	LL			
Read Data Error on TLB Reload	-	0h	BUS	SRC	0	RD	MEM/I O	LG	1	1	1
Read Data Error on Store	-	0h		SRC	0	DWR	MEM/I O	LG	1	1	1
Read Data Error on Load	-	0h		SRC	0	DRD	MEM/I O	LG	1	1	1
1. If an MCA error causes an unlocking store to miss in both the L1DTLB and L2DTLB, the error is uncorrectable. Both PCC and UC will be set to '1'.											

MSR0000_0402 MC0 Machine Check Address (MC0_ADDR)

Read-write; Updated-by-hardware. Cold reset: 0000_0000_0000_0000h. The MCi_ADDR register contains valid data if indicated by MCi_STATUS[AddrV]. See 2.16.1 [Machine Check Architecture]. MSR0000_0000 is an alias of MSR0000_0402.

Bits	Description
63:0	ADDR: Address. See Table 222.

Table 222: MC0 Address Register

Error Type	Error Sub-type	Bits	Description
Data or Tag Parity	Load, Store, HW Prefetch	39:4	PhysAddr[39:4].
Copyback Parity		11:6	PhysAddr[11:6].
Tag Snoop Parity		39:6	PhysAddr[39:6].
BTLB Parity		47:12	LinAddr[47:12].
BTLB Multismatch			
Read Data Error	TLB Reload, Load, or Store	39:4	PhysAddr[39:4].

MSR0000_0403 MC0 Machine Check Miscellaneous (MC0_MISC)

Bits	Description
63:0	Reserved.

MSR0000_0404 MC1 Machine Check Control (MC1_CTL)

Read-write.

Reset: 0000_0000_0000_0000h. See 2.16.1 [Machine Check Architecture].

Bits	Description
63:13	Unused.
12	Unused.
11:10	Unused.
9	SRDE: read data errors. Report system read data errors for an instruction cache fetch if MSR0000_0400[SRDE_ALL] = 1.
8:7	Unused.
6	TLBP: TLB parity errors. Report TLB parity errors.BTLB Parity and Multimatch.
5	Unused.
4	ISTP: snoop tag array parity errors. Report instruction cache snoop tag array parity errors which occur during snoop.
3	ITP: tag array parity errors. Report instruction cache tag array parity errors.
2	IDP: data array parity errors. Report instruction cache data array parity errors.
1	IVP: victim parity errors. Report victim parity errors.
0	PRPE: ME patch RAM parity error. Report patch ram parity errors.

MSR0000_0405 MC1 Machine Check Status (MC1_STATUS)

See 2.16.1 [Machine Check Architecture]. See [MSRC001_0015\[McStatusWrEn\]](#). [Table 223](#) describes each error type. [Table 224](#) describes the error codes and status register settings for each error type.

Bits	Description								
63	Val: error valid. See: MSR0000_0401[Val] .								
62	Overflow: error overflow. See: MSR0000_0401[Overflow] .								
61	UC: error uncorrected. See: MSR0000_0401[UC] .								
60	En: error enable. See: MSR0000_0401[En] .								
59	MiscV: miscellaneous error register valid. Value: 0. See: MSR0000_0401[MiscV] . 1=Valid thresholding in MSR0000_0407 .								
58	AddrV: error address valid. See: MSR0000_0401[AddrV] .								
57	PCC: processor context corrupt. See: MSR0000_0401[PCC] .								
56:40	Reserved.								
39:36	Way: cache way in error. Read-write; Updated-by-hardware.Cold reset: 0. Indicates the cache way in error. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Way 0</td></tr> <tr> <td>1h</td><td>Way 1</td></tr> <tr> <td>Fh-2h</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Way 0	1h	Way 1	Fh-2h	Reserved
Bits	Description								
0h	Way 0								
1h	Way 1								
Fh-2h	Reserved								

35:28	Reserved.
27:24	PRParity[3:0]: ME Patch Ram Parity [3:0] . Read-write; updated-by-hardware. Cold reset: 0.
23:21	Reserved.
20:16	ErrorCodeExt: extended error code . Read-write; updated-by-hardware. Cold reset: 0. See Table 224 for expected values.
15:0	ErrorCode: error code . Read-write; updated-by-hardware. Cold reset: 0. See 2.16.1.5 [Error Code] for details on decoding this field. See Table 224 for expected values.

Table 223: MC1 Error Descriptions

Error Type	Error	Description	CTL ³	CID ²	EAC ¹
Read Data Error		An error occurred during an attempted read of data from the NB. Possible reasons include master abort and target abort.	SRDE		
Data or Tag Parity		An IC data or tag array parity error for a tag hit occurred during instruction fetch from the IC. The data is discarded from the IC, the data array and all tag arrays are cleared, and the line is refetched.	IDP, ITP		
Tag Snoop		A tag error was encountered during snoop or victimization.	ISTP		
Victim Parity		IC Tag parity error as a result of victim cast-out.	IVP		
BTLB Parity		Parity error in BTLB.	TLBP		
BTLB Multimatch		Hit multiple entries.	TLBP		
PRPE PatchRam Parity		Microcode Patch RAM Parity Error	PRPE		
<ol style="list-style-type: none"> 1. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. 2. CID: core ID. A=Error reported to the affected core. 0=Error reported to core 0 of the L2 complex. B=Error reported to all cores of the L2 complex. See 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. 3. See MSR0000_0404. 					

Table 224: MC1 Error Signatures

Error Type	Error	ErrorCod eExt	Error Code						UC	ADDRV	PCC
			Type	PP	TT	RRRR	II/TT	LL			
Read Data Error		0h	BUS	SRC	0	IRD	MEM	LG	1	1	0
Data Parity		0h	MEM	-	-	IRD	Instr	L1	0	1	0
Tag Parity		1h	MEM	-	-	IRD	Instr	L1	0	1	0
Tag Snoop		0h	MEM	-	-	Snoop	Instr	L1	1	1	1
Victim Parity		0h	MEM	-	-	-	Instr	L1	0	1	0

Table 224: MC1 Error Signatures

Error Type	Error	ErrorCodeExt	Error Code						UC	ADDRV	PCC
			Type	PP	TT	RRRR	II/TT	LL			
BTLB Parity		0h	TLB	-	-	-	Instr	L2	0	1	0
BTLB Multimatch		1h	TLB	-	-	-	Instr	L2	0	1	0
PRPE PatchRam Parity		2h	MEM	-	-	-	Instr	LG	1	1	0

MSR0000_0406 MC1 Machine Check Address (MC1_ADDR)

Read-write; Updated-by-hardware. Cold reset: 0000_0000_0000_0000h. The MCi_ADDR register contains valid data if indicated by MCi_STATUS[AddrV]. See 2.16.1 [Machine Check Architecture].

Bits	Description
63:0	ADDR: Address. See Table 225.

The following table defines the address register as a function of error type.

Table 225: MC1 Address Register

Error Type	Error Sub-Type	Bits	Description
IC Data and Tag Parity		47:4	Linear address
Tag Snoop		39:6	Physical address
Victim Parity		47:6	Linear Address
BTLB Parity		47:4	Linear address
BTLB Multimatch			
PRPE PatchRam ParityError		12:0	Patch Ram Address
BU Read Data Error	-	63:40	Reserved.
		39:6	PhysAddr[47:6] .
		5:0	Reserved.

MSR0000_0407 MC1 Machine Check Miscellaneous (MC1_MISC)

Bits	Description
63:0	Reserved.

MSR0000_0408 MC2 Machine Check Control (MC2_CTL)

Read-write; [Per-L2](#); not-same-for-all.

Reset: 0000_0000_0000_0000h. See 2.16.1 [Machine Check Architecture]. See MSRC001_0046 [BU Machine Check Control Mask (MC2_CTL_MASK)].

Bits	Description
63:14	Unused.
13	AttrParity: attribute parity errors.
12:9	Unused.
8	DataUncor: uncorrectable data errors.
7	DataCor: correctable data errors.
6	DataParity: data parity errors.
5	TagUncor: uncorrectable tag errors.
4	TagCor: correctable tag errors.
3	Unused.
2	IBUFF: NB read response error due to a fill.
1	OBUFF: NB read response error due to a write/victim.
0	Unused.

MSR0000_0409 MC2 Machine Check Status (MC2_STATUS)

IF (MSRC001_10A0[McaToMstCoreEn]) THEN Per-L2; not-same-for-all. ENDIF. See 2.16.1 [Machine Check Architecture]. See MSRC001_0015[McStatusWrEn]. Table 226 describes each error type. Table 227 describes the error codes and status register settings for each error type. See MSRC001_10A0[McaToMstCoreEn].

Bits	Description
63	Val: error valid. See: MSR0000_0401[Val].
62	Overflow: error overflow. See: MSR0000_0401[Overflow].
61	UC: error uncorrected. See: MSR0000_0401[UC].
60	En: error enable. See: MSR0000_0401[En].
59	MiscV: miscellaneous error register valid. Value: 0. See: MSR0000_0401[MiscV]. 1=Valid thresholding in MSR0000_040B.
58	AddrV: error address valid. See: MSR0000_0401[AddrV].
57	PCC: processor context corrupt. See: MSR0000_0401[PCC].
56	ErrCoreIdVal. Read-write; Updated-by-hardware. Cold reset: 0. 1=The ErrCoreId field is valid.
55	Reserved.

54:47	Syndrome[7:0] . Read-write; Updated-by-hardware. Cold reset: 0. The syndrome bits when an ECC error is detected. See Table 227 for when Syndrome is valid. Syndrome[15:0] = {Syndrome[15:8], Syndrome[7:0]}. <table> <tr> <th>Array</th><th>Description</th></tr> <tr> <td>L2 Tag</td><td>Syndrome[7:0]. (Syndrome[15:8] is 0)</td></tr> <tr> <td>L2 Data</td><td>Syndrome[8:0]. (Syndrome[15:9] is 0)</td></tr> <tr> <td>NbRead, NbFill</td><td>Syndrome[15:0]. Even parity.</td></tr> </table>	Array	Description	L2 Tag	Syndrome[7:0]. (Syndrome[15:8] is 0)	L2 Data	Syndrome[8:0]. (Syndrome[15:9] is 0)	NbRead, NbFill	Syndrome[15:0]. Even parity.		
Array	Description										
L2 Tag	Syndrome[7:0]. (Syndrome[15:8] is 0)										
L2 Data	Syndrome[8:0]. (Syndrome[15:9] is 0)										
NbRead, NbFill	Syndrome[15:0]. Even parity.										
46	CECC: correctable ECC error . Read-write; Updated-by-hardware. Cold reset: 0. 1=The error was a correctable ECC error.										
45	UECC: uncorrectable ECC error . Read-write; updated-by-hardware. Cold reset: 0. 1=The error was an uncorrectable ECC error.										
44	Deferred: deferred error . See: MSR0000_0401 [Deferred].										
43	Poison: poison error . See: MSR0000_0401 [Poison].										
42	Reserved.										
41:36	Way: cache way/entry in error . Read-write; Updated-by-hardware. Cold reset: 0. Indicates the cache way in error. See Table 227 for when Way is valid and what ways are valid. IF ((ErrorCodeExt==00100b)) THEN CRQ IBUFF error location specified by {Way, MSR0000_040A [5:4]}. ELSEIF ((ErrorCodeExt==00101b)) THEN CRQ OBUFF error location specified by {Way, MSR0000_040A [5:4]}. ELSE <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Way 0</td></tr> <tr> <td>01h</td><td>Way 1</td></tr> <tr> <td>0Eh-02h</td><td>Way <Way></td></tr> <tr> <td>0Fh</td><td>Way 15</td></tr> </table> ENDIF	Bits	Description	00h	Way 0	01h	Way 1	0Eh-02h	Way <Way>	0Fh	Way 15
Bits	Description										
00h	Way 0										
01h	Way 1										
0Eh-02h	Way <Way>										
0Fh	Way 15										
35:32	ErrCoreId . Read-write; Updated-by-hardware. Cold reset: 0. When ErrCoreIdVal=1, this field indicates which core within the processor is associated with the error; otherwise this field is reserved.										
31:24	Syndrome[15:8] . See: MSR0000_0409 [Syndrome[7:0]].										
23:21	Reserved.										
20:16	ErrorCodeExt: extended error code . Read-write; updated-by-hardware. Cold reset: 0. See MSR0000_0401 [ErrorCodeExt]. See Table 227 for expected values.										
15:0	ErrorCode: error code . Read-write; Updated-by-hardware. Cold reset: 0. See 2.16.1.5 [Error Code] for details on decoding this field. See Table 227 for expected values.										

Table 226: MC2 Error Descriptions

Error Type	Error	Description	CTL ³	CID ²	EAC ¹
NB	IBUFF	A parity error occurred in the IBUFF.	IBUFF	-	E ¹
NB	OBUFF	A parity error occurred in the OBUFF.	OBUFF	-	E ¹

Table 226: MC2 Error Descriptions

Error Type	Error	Description	CTL ³	CID ²	EAC ¹
L2 Cache	L2Tag	A correctable or uncorrectable ECC error was seen in the L2 tag.	TagCor, TagUncor	-	E ¹
L2 Cache	L2Data	A correctable or uncorrectable ECC error was seen in the L2 data array.	DataParity, DataCor, DataUncor.	-	E ¹
Attribute Parity	Par	A parity error was seen in the L2 attribute bits. This error was corrected by hardware.	AttrParity	A ²	E ¹

1. EAC: The error action is taken if detected for all CU errors. D=Error action taken if detected. E=Error action taken if MCA bank enabled. See 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. If any core in the L2 complex has MCG_CTL[2] asserted, the MCA logic in the L2I is enabled.
2. CID: core ID. A=Error reported to the affected core. 0=Error reported to core 0 of the L2 complex; see 2.16.1.3 [Error Detection, Action, Logging, and Reporting].
3. See MSR0000_0408.
4. Error Action: Sync flood=Take sync flood if PCC=1. None=No action other than that specified by MCA.

Table 227: MC2 Error Signatures

Error Type	Error Sub-Type	Sub	Error CodeExt	Error Code						UC	ADDRV	PCC	Syndrome	Way	CECC	UECC	ErrCoreIdVal
				Type	PP	T	RRRR	II/TT	LL								
NB	IBUFF	-	04h	MEM	-	-	RD	G	L2	1	1	1	15:0	5:0	0	0	0
	OBUFF		05h				WR										
Tag	Cor	BankReq	09h	MEM	-	-	GEN	G	L2	0	1	0	7:0	3:0	1/0	0	1
		Prb	0Ah				Probe										0
		Fill	0Bh				RD										1
Tag	Uncor	BankReq	0Dh	MEM	-	-	GEN	G	L2	1	1	1	7:0	3:0	0	1	1
		Prb	0Eh				Probe										0
		Fill	0Fh				RD										1
Data	Cor	Hit	10h	MEM	-	-	RD	G	L2	0	1	0	8:0	3:0	1/0	0	1
		Attr	11h				GEN										1
		Vict	12h				Evict										0
		Fill	13h				RD										1
Data	Uncor	Hit	14h	MEM	-	-	RD	G	L2	1	1	1	8:0	3:0	0	1	1
		Attr	15h				GEN										1
		Vict	16h				Evict										0
		Fill	17h				RD										1
Data	Par	Hit	18h	MEM	-	-	RD	G	L2	0	1	0	-	3:0	0	0	1
		Attr	19h				GEN										
		Fill	1Bh				IRD										
Attr	Par	Hit	1Ch	MEM	-	-	RD	G	L2	0	1	0	-	3:0	0	0	1
		Attr	1Dh				GEN										
		Fill	1Fh				IRD										

MSR0000_040A MC2 Machine Check Address (MC2_ADDR)

Read-write; Updated-by-hardware. Cold reset: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). The following table defines the address register as a function of error type.

This register is shared by all cores of the L2 complex when the [MSRC001_10A0\[McaToMstCoreEn\]](#)==0.

When ([MSRC001_10A0\[McaToMstCoreEn\]](#)==1), only the lowest enabled core in the complex can read/write this register. All other cores will read all 0s and writes will be ignored.

Bits	Description
63:40	Reserved.
39:4	ADDR. Read-write; updated-by-hardware. See Table 228 .
3:0	Reserved.

Table 228: MC2 Address Register

Error Type	Error Sub-Type	Bits	Description
L2 Tag	Error Code Ext=0 9h to 0Fh.	63:17	Reserved.
		16:6	PhysAddr[16:6] .
		5:0	Reserved.
Data, Attr, NB	Error Code Ext=0 4h to 05h, 10h to 1Fh.	63:40	RAZ
		39:4	PhysAddr[39:4] .
		3:0	RAZ

MSR0000_040B MC2 Machine Check Miscellaneous (MC2_MISC)

Bits	Description
63:0	Reserved.

MSR0000_040C MC3 Machine Check Control (MC3_CTL)

Reset: 0000_0000_0000_0000h. Read-only.

Bits	Description
63:0	Unused.

MSR0000_040D MC3 Machine Check Status (MC3_STATUS)

Reset: 0. See [MSRC001_0015\[McStatusWrEn\]](#).

Bits	Description
63:0	Reserved.

MSR0000_040E MC3 Machine Check Address (MC3_ADDR)

Reset: 0000_0000_0000_0000h. Read-only.

Bits	Description
63:0	Reserved.

MSR0000_040F MC3 Machine Check Miscellaneous (MC3_MISC)

Reset: 0000_0000_0000_0000h. Read-only.

Bits	Description
63:0	Reserved.

MSR0000_0410 MC4 Machine Check Control (MC4_CTL)

Read-write; **Not-same-for-all**. Reset: 0000_0000_0000_0000h.

[MSR0000_0410](#)[31:0] is an alias of [D18F3x40](#), which is accessible through PCI configuration space. Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#).

Accessibility of this register by non-NBC cores is affected by [D18F3x44](#)[NbMcaToMstCpuEn].

See [D18F3x44 \[MCA NB Configuration\]](#) for further NB MCA configuration controls. See [2.16.1 \[Machine Check Architecture\]](#) for a general description of the machine check architecture. See [MSRC001_0048 \[NB Machine Check Control Mask \(MC4_CTL_MASK\)\]](#) for the corresponding error mask register.

Bits	Description
63:32	Unused.
31	McaCpuDatErrEn: L2 complex data error. 1=Enables MCA reporting of CPU data errors sent to the NB.
30	Unused.
29:28	Unused.
27	Unused.
26	NbArrayParEn: northbridge array parity error reporting enable. 1=Enables reporting of parity errors in the NB arrays.
25	UsPwDatErrEn: upstream data error enable. Read-write. 1=Enables MCA reporting of upstream posted writes in which the EP bit is set.
24:18	Unused.
17	CpPktDatEn: completion packet error reporting enable. Read-write. 1=Enables MCA reporting of completion packets with the EP bit set.
16	NbIntProtEn: northbridge internal bus protocol error reporting enable. Read-write. 1=Enables MCA reporting of protocol errors detected on the northbridge internal bus. When possible, this enable should be cleared before initiating a warm reset to avoid logging spurious errors due to RESET_L signal skew.
15:13	Unused.
12	WDTRptEn: watchdog timer error reporting enable. 1=Enables MCA reporting of watchdog timer errors. The watchdog timer checks for NB system accesses for which a response is expected but no response is received. See D18F3x44 [MCA NB Configuration] for information regarding configuration of the watchdog timer duration. This bit does not affect operation of the watchdog timer in terms of its ability to complete an access that would otherwise cause a system hang. This bit only affects whether such errors are reported through MCA.

11	AtomicRMWEn: atomic read-modify-write error reporting enable. 1=Enables MCA reporting of atomic read-modify-write (RMW) commands received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by this bit.
10	Unused.
9	TgtAbortEn: target abort error reporting enable. 1=Enables MCA reporting of target aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.
8	MstrAbortEn: master abort error reporting enable. 1=Enables MCA reporting of master aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.
7:6	Unused.
5	SyncPktEn: link sync packet error reporting enable. 1=Enables MCA reporting of link-defined sync error packets detected on link. The NB floods its outgoing link with sync packets after detecting a sync packet on the incoming link independent of the state of this bit.
4:2	Unused.
1	UECCEn: uncorrectable ECC error reporting enable. 1=Enables MCA reporting of DDR3 DRAM uncorrectable ECC errors which are detected in the NB. In some cases data may be forwarded to the core prior to checking ECC in which case the check takes place in one of the other error reporting banks.
0	CECCEn: correctable ECC error reporting enable. 1=Enables MCA reporting of DDR3 DRAM correctable ECC errors which are detected in the NB.

MSR0000_0411 MC4 Machine Check Status (MC4_STATUS)

Not-same-for-all. Cold reset: 0000_0000_0000_0000h.

MSR0000_0411[63:32] is an alias of D18F3x4C, and MSR0000_0411[31:0] is an alias of D18F3x48. Only one of these registers exists in multi-core devices; see 3.1.1 [Northbridge MSRs In Multi-Core Products]. Accessibility of this register by non-NBC cores is affected by D18F3x44[NbMcaToMstCpuEn]. See MSRC001_0015[McStatusWrEn] for information on writing to this register. See 2.16.1 [Machine Check Architecture] for machine check architecture background.

Table 229 describes each error type. Table 230 and Table 231 describe the error codes and status register settings for each error type.

Bits	Description
63	Val: valid. See: MSR0000_0401[Val].
62	Overflow: error overflow. See: MSR0000_0401[Overflow].
61	UC: error uncorrected. See: MSR0000_0401[UC].
60	En: error enable. See: MSR0000_0401[En].
59	MiscV: miscellaneous error register valid. See: MSR0000_0401[MiscV]. 1=Valid thresholding in MSR0000_0413 or MSRC000_0408.
58	AddrV: error address valid. See: MSR0000_0401[AddrV].
57	PCC: processor context corrupt. See: MSR0000_0401[PCC].

56	ErrCoreIdVal: error core ID is valid. Read-write; set-by-hardware. 1=The ErrCoreId field is valid.
55	Reserved.
54:47	Syndrome[7:0]. Read-write. Syndrome[15:0] = {Syndrome[15:8], Syndrome[7:0]}. The syndrome bits when an ECC error is detected. See Table 231 Valid Syndrome column for which bits are valid for each error.
46	CECC: correctable ECC error. Read-write; Updated-by-hardware. 1=The error was a correctable ECC error according to the restrictions of the ECC algorithm. UC indicates whether the error was actually corrected by the processor.
45	UECC: uncorrectable ECC error. Read-write; Updated-by-hardware. 1=The error was an uncorrectable ECC error according to the restrictions of the ECC algorithm. UC indicates whether the error was actually corrected by the processor.
44	Deferred: deferred error. Read-write; Updated-by-hardware. 1=A deferred error was created. A deferred error is the result of an uncorrectable data error which did not immediately cause a processor exception; the data is poisoned and an exception is deferred until the data is consumed.
43:42	Reserved.
41	SubLink: sublink. Read-write; set-by-hardware. For errors associated with a link, this bit indicates if the error was associated with the upper or lower byte of the link. 0=Sublink [7:0]. 1=Sublink [15:8].
40	Scrub: error detected on a scrub. Read-write; Set-by-hardware.
39:37	Reserved.
36	Link. Read-write; set-by-hardware. For errors associated with a link, this field indicates that the link was associated with the error.
35:32	ErrCoreId: error associated with core N. Read-write; updated-by-hardware. When ErrCoreIdVal=1 this field indicates which core within the processor is associated with the error; otherwise this field is reserved. All values greater than D18F5x84 [CmpCap] are reserved.
31:24	Reserved.
23:21	Reserved.
20:16	ErrorCodeExt: extended error code. Read-write; Updated-by-hardware. See MSR0000_0401 [ErrorCodeExt]. See Table 230 for values.
15:0	ErrorCode: error code. Read-write; Updated-by-hardware. See 2.16.1.5 [Error Code] .

Table 229: MC4 Error Descriptions

Error Type	Description	CTL ¹	ETG ²	EAC ⁴
Sync Error	Link-defined sync error packets detected on link. The NB floods its outgoing links with sync packets after detecting a sync packet on an incoming link independent of the state of the control bits.	SyncPktEn	L	D
Master Abort	Master abort seen as result of link operation. Reasons for this error include requests to non-existent addresses. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of the control bit.	MstrAbortEn	L	D
Target Abort	Target abort seen as result of link operation. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of the control bit.	TgtAbortEn	L	D

Table 229: MC4 Error Descriptions

Error Type	Description	CTL ¹	ETG ²	EAC ⁴
RMW Error	An atomic read-modify-write (RMW) command was received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by the control bit.	AtomicRMWEn	L	D
WDT Error	NB WDT timeout due to lack of progress. The NB WDT monitors transaction completions. A transaction that exceeds the programmed time limit reports errors via the MCA. The cause of error may be another node or device which failed to respond.	WDTRptEn	L	D
DRAM ECC Error	A DRAM ECC error detected.	CECCEn, UECCEn	D	D
DRAM CRC Error	A DRAM CRC error was detected.	CCRCEn, UCRCEn	D	D
Link Data Error	Data error detected on link. If enabled for reporting and the request is sourced from a core, then PCC is set. (If not enabled for reporting, PCC is not set. If configured to allow an error response to be returned to the core, this could allow error containment to a scope smaller than the entire system.)	McaUsPwDatErrEn, CpPktDatEn	L	D
Protocol Error	Protocol error detected by link. These errors are distinguished from each other by the value in MSR0000_0412[ErrAddr] . See Table 233 . For protocol errors, the system cannot continue operation. Protocol errors can be caused by other subcomponents than the one reporting the error. For diagnosis, collect and examine MCA registers from other banks, cores, and processors in the system.	NbIntProtEn	L ³	D
NB Array Error	A parity error was detected in the NB internal arrays.	NbArrayParEn	-	D
L2 complex Data Error	NB received a data error from a core and this error could not be contained. For the cause of the data error, examine the core MCA registers for deferred errors. This error may occur for the following types of data writes: <ul style="list-style-type: none"> • APIC • Configuration space (IO and MMIO) For these errors, sync flood will occur if D18F3x180[SyncFloodOnCpuLeakErr] is set.	McaCpuDatErrEn	-	D
<p>1. CTL: See MSR0000_0410.</p> <p>2. ETG: error threshold group. See 2.16.1.7 [Error Thresholding].</p> <ul style="list-style-type: none"> • L=Link. • D=DRAM. <p>3. The error thresholding group is Link if link protocol error; none for non-link protocol error.</p> <p>4. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled.</p>				

The NB is capable of reporting the following errors:

Table 230: MC4 Error Signatures, Part 1

Error Type	ErrorCode-Ext	Error Code					
		Type	PP	T	RRRR	II/TT	LL
Reserved	00h	-	-	-	-	-	-
Reserved	01h	-	-	-	-	-	-
Sync Error	02h	BUS	OBS	0	GEN	GEN	LG
Mst Abort	03h	BUS	SRC/OBS	0	RD/WR	MEM/IO ¹	LG
Tgt Abort	04h	BUS	SRC/OBS	0	RD/WR	MEM/IO ¹	LG
RMW Error	06h	BUS	OBS	0	GEN	IO	LG
WDT Error	07h	BUS	GEN	1	GEN	GEN	LG
ECC Error	08h	BUS	SRC/RES	0	RD/WR	MEM	LG
Link Data Error	0Ah	BUS	SRC/OBS	0	RD/WR/ DWR	MEM/IO	LG
NB Protocol Error	0Bh		OBS	0	GEN	GEN	LG
NB Array Error	0Ch		OBS	0	GEN	GEN	LG
L2 complex Data Error	19h	MEM	-	-	WR	Data	LG
1. Indicates the type of link attached to the reporting NB, not the instruction type. MEM indicates coherent link, IO indicates IO link.							

Table 231: MC4 Error Signatures, Part 2

Error Type	UC	AddrV	PCC	Syndrome Valid	CECC	UECC	Deferred	Scrub	Link	Err CoreId
Sync Error	1	0	1	-	0	0	0	0	Y	-
Mst Abort	1	1	Core ¹⁰	-	0	0	0	0	Y	Y
Tgt Abort	1	1	Core ¹⁰	-	0	0	0	0	Y	Y
RMW Error	1	1	0	-	0	0	0	0	Y	-
WDT Error	1	0 ¹	1	-	0	0	0	0	-	-
		1 ²								
ECC Error	MS ⁶	1	MS ⁶ & Core	15:0	~MS ⁶	MS ⁶	0	1/0	-	-
Link Data Error	~Deferred ¹¹	1	0	-	0	0	0/1	0	Y	-
NB Protocol Error	1	1/0 ²	1	-	0	0	0	0	Y	-
NB Array Error	~Deferred ¹¹	1 ⁴	~Deferred ¹¹	-	0	0	0/1	0	-	-
L2 complex Data Error	1	0	1	-	0	0	0	0	-	Y

Table 231: MC4 Error Signatures, Part 2

Error Type	UC	AddrV	PCC	Syndrome Valid	CECC	UECC	Deferred	Scrub	Link	Err CoreId
<ol style="list-style-type: none"> See Table 237 [Format of MSR0000_0412[ErrAddr[47:1]] for Watchdog Timer Errors]. See Table 233 [Format of MSR0000_0412[ErrAddr[47:1]] for Protocol Errors]. See Table 236 [Valid Values for ArrayErrorType]. MS: multi-symbol. 1=Multi-symbol. 0=Not multi-symbol. Core: source is core. 1=Source is core. 0=Source is not core. Deferred: error is deferred. 1=Error is deferred. 0=Error is not deferred. 										

MSR0000_0412 MC4 Machine Check Address (MC4_ADDR)

IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; [Per-node](#); not-same-for-all. ELSE Read-write; [Per-node](#); not-same-for-all. ENDIF. Cold reset: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). MSR0000_0412[31:0] is an alias of D18F3x50. MSR0000_0412[63:32] is an alias of D18F3x54. Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#). ErrAddr[47:1] carries supplemental information associated with a machine check error, generally the address being accessed. Accessibility of this register by non-NBC cores is affected by D18F3x44[NbMcaToMstCpuEn]. The format of ErrAddr[47:1] is a function of MSR0000_0411[ErrorCodeExt]; See ErrAddr[47:1].

Bits	Description
63:48	Reserved. Value: 00h.
47:32	ErrAddr[47:32]: Error Address Bits[47:32] . See: ErrAddr[31:1].
31:1	ErrAddr[31:1]: Error Address Bits[31:1] . ErrAddr[47:0] = {MSR0000_0412[ErrAddr[47:32]], MSR0000_0412[ErrAddr[31:1]], MSR0000_0412[ErrAddr[0]]}. See the tables below for the encoding.
0	ErrAddr[0]: Error Address Bit[0] .

The register format depends on the type of error being logged:

- Protocol errors contain the error reason code, may contain the physical address, and are formatted according to [Table 233](#).
- NB array errors indicate the array in error, and are formatted according to [Table 235](#).
- NB Watchdog timer errors depend on the mode selected by D18F3x180[McaLogErrAddrWdtErr], and the format is indicated by D18F3x4C[AddrV]. If D18F3x4C[AddrV] is indicated, errors are formatted according to [Table 232](#). If D18F3x4C[AddrV] is not indicated, errors are formatted according to [Table 237](#).
- All other NB errors which indicate D18F3x4C[AddrV] are formatted according to [Table 232](#).

Table 232: Format of MSR0000_0412[ErrAddr[47:1]] for All Other Errors

Bits	Description
47:1	PhysAddr[47:1] .

Table 233: Format of MSR0000_0412[ErrAddr[47:1]] for Protocol Errors

Bits	Description
47:6	PhysAddr[47:6] . Valid of (MSR0000_0411[AddrV]==1); otherwise reserved.
5:1	ProtocolErrorType . See Table 234 [Valid Values for ProtocolErrorType] .

Table 234: Valid Values for ProtocolErrorType

Bits	Description
00h	Link: SRQ Read Response without matching request
01h	Link: Probe Response without matching request
02h	Link: TgtDone without matching request
03h	Link: TgtStart without matching request
04h	Link: Command buffer overflow
05h	Link: Data buffer overflow
06h	Link: Link retry packet count acknowledge overflow
07h	Link: Data command in the middle of a data transfer
08h	Link: Link address extension command followed by a packet other than a command with address.
09h	Link: A specific coherent-only packet from a CPU was issued to an IO link.
0Ah	Link: A command with invalid encoding was received. This error occurs when: <ul style="list-style-type: none"> 1. Any invalid command is received (including a command with no valid encoding or a coherent link command over an IO link or vice versa) while not in retry mode. 2. Any illegal command is received in which the CRC is correct while in retry mode (including any upstream broadcast command (link command encoding = 11101xb)).
0Bh	Link: Link CTL deassertion occurred when a data phase was not pending. This error condition may only occur when error-retry mode is not enabled (if it is enabled, this condition triggers a retry).
0Fh-0Ch	Reserved
1Fh-10h	Reserved

Table 235: Format of [MSR0000_0412](#)[ErrAddr[47:1]] for NB Array Errors

Bits	Description
47:6	Reserved.
5:1	ArrayErrorType . See Table 236 [Valid Values for ArrayErrorType] .

Table 236: **Valid Values** for ArrayErrorType

Bits	Description
00h	SRA: System request address.
01h	SRD: System request data.
02h	SPB: System packet buffer.
03h	MCD: Memory controller data.
04h	MPB: Memory packet buffer.
05h	LPB0: Link 0 packet buffer.
08h-06h	Reserved.
09h	MPBC: Memory controller command packet buffer.
0Ah	MCDBM: Memory controller byte mask.
0Bh	MCACAM: Memory controller address array.

Table 236: **Valid Values** for ArrayErrorType

Bits	Description
0Ch	DMAp: Extended DRAM address map.
0Dh	MMAP: Extended MMIO address map.
0Eh	X86MAP: Extended PCI/IO address map.
0Fh	CFGMAP: Extended config address map.
17h-10h	Reserved.
18h	SRIMCTRTE: SRI/MCT extended routing table.
1Ch-19h	Reserved
1Dh	TCB: TCB array.
1Fh-1Eh	Reserved

Table 237: Format of MSR0000_0412[ErrAddr[47:1]] for Watchdog Timer Errors

Bits	Description																
47:40	CoreId. Indicates the core ID if the SourcePointer specifies Core. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>07h-00h</td><td>CoreId</td></tr> <tr> <td>FFh-08h</td><td>Reserved</td></tr> </table>	Bits	Description	07h-00h	CoreId	FFh-08h	Reserved										
Bits	Description																
07h-00h	CoreId																
FFh-08h	Reserved																
39:36	SystemResponseCount. This field records unspecified, implementation-specific information.																
35:31	WaitCode. records unspecified, implementation-specific information (all zeroes means no waiting condition).																
30	WaitForPostedWrite.																
29:27	DestinationNode. Records the Node ID of the node addressed by the transaction.																
26:25	DestinationUnit. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Core</td></tr> <tr> <td>01b</td><td>Extended Core</td></tr> <tr> <td>10b</td><td>Memory Controller</td></tr> <tr> <td>11b</td><td>Host</td></tr> </table>	Bits	Description	00b	Core	01b	Extended Core	10b	Memory Controller	11b	Host						
Bits	Description																
00b	Core																
01b	Extended Core																
10b	Memory Controller																
11b	Host																
24:22	SourceNode. Records the Node ID of the node originating the transaction.																
21:20	SourceUnit. (same encoding as Destination Unit)																
19:15	SourcePointer. Identifies crossbar source: <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>SRI HostBridge</td></tr> <tr> <td>03h-01h</td><td>Reserved</td></tr> <tr> <td>04h</td><td>Core. See CoreId.</td></tr> <tr> <td>07h-05h</td><td>Reserved</td></tr> <tr> <td>08h</td><td>Memory controller.</td></tr> <tr> <td>0Fh-09h</td><td>Reserved</td></tr> <tr> <td>1Fh-10h</td><td>Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved.</td></tr> </table>	Bits	Description	00h	SRI HostBridge	03h-01h	Reserved	04h	Core. See CoreId.	07h-05h	Reserved	08h	Memory controller.	0Fh-09h	Reserved	1Fh-10h	Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved.
Bits	Description																
00h	SRI HostBridge																
03h-01h	Reserved																
04h	Core. See CoreId.																
07h-05h	Reserved																
08h	Memory controller.																
0Fh-09h	Reserved																
1Fh-10h	Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved.																

Table 237: Format of [MSR0000_0412](#)[ErrAddr[47:1]] for Watchdog Timer Errors

Bits	Description
14:11	SrqEntryState. Records unspecified, implementation-specific information (all zeroes means idle).
10:7	OpType. Records unspecified, implementation-specific information.
6:1	LinkCommand. When the NB WDT expires, the link command of the transaction that timed out is captured here. This field is encoded identically to the “Code” field for link transactions defined in the link specification.

MSR0000_0413 NB Machine Check Misc 4 (DRAM Thresholding) 0 (MC4_MISC0)

[MSR0000_0413](#) is the first of the NB machine check miscellaneous registers. [MSR0000_0413](#) is associated with the DRAM error type. To see the remaining NB machine check miscellaneous registers, refer to [MSRC000_0408](#). Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#).

Bits	Description						
63	Valid. IF (D18F3x44 [NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015 [McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 1. ENDIF. 1=The CntP field is present.						
62	CntP: counter present. IF (D18F3x44 [NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015 [McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 1. ENDIF. 1=A valid threshold counter is present.						
61	Locked. IF (D18F3x44 [NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015 [McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 0. ENDIF. BIOS: IF (IntType==10b) THEN 1. ELSE 0. ENDIF. 1=Writes to bits [55:32] of this register are ignored. Set by BIOS to indicate that this register is not available for OS use. When MSRC001_0015 [McStatusWrEn] is set, MSR writes to this register update all bits, regardless of the state of the Locked bit.						
60:56	Reserved.						
55:52	LvtOffset: LVT offset. IF (D18F3x44 [NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015 [McStatusWrEn] ~ MSR0000_0413 [Locked]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 0h. ENDIF. Specifies the address of the LVT entry in the APIC registers as follows: LVT address = (LvtOffset shifted left 4 bits) + 500h (see APIC[530:500]). <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>See APIC[530:500].</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Description	3h-0h	See APIC[530:500] .	Fh-4h	Reserved
Bits	Description						
3h-0h	See APIC[530:500] .						
Fh-4h	Reserved						
51	CntEn: counter enable. IF (D18F3x44 [NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015 [McStatusWrEn] ~Locked) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 0. ENDIF. 1=Count thresholding errors. See 2.16.1.7 [Error Thresholding] .						

50:49	<p>IntType: interrupt type. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~MSR0000_0413[Locked]) THEN Read-write; Per-node; not-same-for-all. ELSE Read-only; Per-node; not-same-for-all. Cold reset: 0. ENDIF. Specifies the type of interrupt signaled when Ovrflw is set.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No Interrupt.</td></tr> <tr> <td>01b</td><td>APIC. APIC based interrupt (see LvtOffset above) to all cores.</td></tr> <tr> <td>10b</td><td>SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	No Interrupt.	01b	APIC. APIC based interrupt (see LvtOffset above) to all cores.	10b	SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].	11b	Reserved
Bits	Description										
00b	No Interrupt.										
01b	APIC. APIC based interrupt (see LvtOffset above) to all cores.										
10b	SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].										
11b	Reserved										
48	<p>Ovrflw: overflow. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~Locked) THEN Read-write; Per-node; not-same-for-all; set-by-hardware. ELSE Read-only; Per-node; not-same-for-all; set-by-hardware. Cold reset: 0. ENDIF. Set by hardware when ErrCnt transitions from FFEh to FFFh. When this bit is set, the interrupt selected by the IntType field is generated.</p>										
47:44	Reserved.										
43:32	<p>ErrCnt: error counter. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~Locked) THEN Read-write; Per-node; not-same-for-all; updated-by-hardware. ELSE Read-only; Per-node; not-same-for-all; updated-by-hardware. Cold reset: 0. ENDIF. Written by software to set the starting value of the error counter. Incremented by hardware when errors are logged. Saturates at FFFh (no rollover). The threshold value, written by software, is (FFFh - the desired error count (the number of errors necessary in order for an interrupt to be taken)).</p>										
31:24	<p>BlkPtr: Block pointer for additional MISC registers. Read-only. Value: 01h. 01h=Extended MC4_MISC MSR block is valid. See MSR0000_0408.</p>										
23:0	Reserved.										

MSR0000_0414 MC5 Machine Check Control (MC5_CTL)

Read-write. Reset: 0000_0000_0000_0000h. See 2.16.1 [Machine Check Architecture]. See MSRC001_0049 [FR Machine Check Control Mask (MC5_CTL_MASK)].

Bits	Description
63:1	Unused.
0	WDT: core watchdog timer. See MSRC001_0074 [CPU Watchdog Timer (CpuWdtCfg)].

MSR0000_0415 MC5 Machine Check Status (MC5_STATUS)

Cold reset: 0000_0000_0000_0000h. See 2.16.1 [Machine Check Architecture]. See MSRC001_0015[McStatusWrEn]. Table 238 describes each error type. Table 239 describes the error codes and status register settings for each error type.

Bits	Description
63	Val: error valid. See: MSR0000_0401[Val].
62	Overflow: error overflow. See: MSR0000_0401[Overflow].

61	UC: error uncorrected. See: MSR0000_0401[UC] .
60	En: error enable. See: MSR0000_0401[En] .
59	MiscV: miscellaneous error register valid. Read-write; Updated-by-hardware. See: MSR0000_0401[MiscV] . 1= MSR0000_0417 is valid.
58	AddrV: error address valid. See: MSR0000_0401[AddrV] . 1=Valid address in MSR0000_0416 .
57	PCC: processor context corrupt. See: MSR0000_0401[PCC] .
56:16	Reserved.
15:0	ErrorCode: error code. Read-write; Updated-by-hardware. See 2.16.1.5 [Error Code] See Table 239 .

Table 238: MC5 Error Descriptions

Error Type	Error Sub-type	Description	CTL ¹	EAC ³
WDT error	-	The WDT timer has expired. See MSRC001_0074 [CPU Watchdog Timer (CpuWdtCfg)] .	WDT	E
<ol style="list-style-type: none"> 1. CTL: See MSR0000_0414. 2. CID: core ID. All EX errors are reported to the affected core; see 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. 3. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See 2.16.1.3 [Error Detection, Action, Logging, and Reporting]. 				

Table 239: MC5 Error Signatures

Error Type	Error Sub-Type	Error CodeExt	Error Code						UC	ADDRV	MISCV	PCC	CECC	UECC
			Type	UU/PP	TT	RRRR	II/TT	LL						
WDT error	-	00h	BUS	GEN	1	GEN	GEN	LG	1	1	1	1	0	0
<ol style="list-style-type: none"> 1. Causes shutdown. 2. Causes shutdown if UC=1. 3. STATQ sets PCC=1 if a store retired in last 3 cycles or FpTokenRet bits mismatch. 														

MSR0000_0416 MC5 Machine Check Address (MC5_ADDR)

Read-write; Updated-by-hardware. Cold reset: 0000_0000_0000_0000h. The MCi_ADDR register contains valid data if indicated by MCi_STATUS[AddrV]. See [2.16.1 \[Machine Check Architecture\]](#). The register format depends on the type of error being logged.

Bits	Description
63:0	ADDR. See Table 240 .

The following tables define the address register as a function of error type.

Table 240: MC5 Address Register

Error Type	Error Sub-Type	Bits	Description
WDT	- (ErrorCodeExt=00h)	63:48	Reserved
		48:0	LogAddr[48:0] . Logical canonical address of the next instruction after the last instruction retired.

MSR0000_0417 MC5 Machine Check Miscellaneous (MC5_MISC)

Cold reset: 0000_0000_0000_0000h.

Bits	Description
63:8	Reserved.
7:0	FrCompl. Read-write.

3.20 MSRs - MSRC000_0xxx**MSRC000_0080 Extended Feature Enable (EFER)**

SKINIT Execution: 0000_0000_0000_0000h.

Bits	Description
63:16	MBZ.
15	MBZ.
14	FFXSE: fast FXSAVE/FRSTOR enable. Read-write. Reset: 0. 1=Enables the fast FXSAVE/FRSTOR mechanism. A 64-bit operating system may enable the fast FXSAVE/FRSTOR mechanism if (CPUID Fn8000_0001_EDX [FFXSR]==1)). This bit is set once by the operating system and its value is not changed afterwards.
13	LMSLE: long mode segment limit enable. Read-write. Reset: 0. 1=Enables the long mode segment limit check mechanism.
12	SVME: secure virtual machine (SVM) enable. IF (MSRC001_0114 [SvmeDisable]==1) THEN MBZ. ELSE Read-write. ENDIF. Reset: 0. 1=SVM features are enabled.
11	NXE: no-execute page enable. Read-write. Reset: 0. 1=The no-execute page protection feature is enabled.
10	LMA: long mode active. Read-only. Reset: 0. 1=Indicates that long mode is active.
9	MBZ.
8	LME: long mode enable. Read-write. Reset: 0. 1=Long mode is enabled.
7:1	RAZ.
0	SYSCALL: system call extension enable. Read-write. Reset: 0. 1=SYSCALL and SYSRET instructions are enabled. This adds the SYSCALL and SYSRET instructions which can be used in flat addressed operating systems as low latency system calls and returns.

MSRC000_0081 SYSCALL Target Address (STAR)

Reset: 0000_0000_0000_0000h. This register holds the target address used by the SYSCALL instruction and the code and stack segment selector bases used by the SYSCALL and SYSRET instructions.

Bits	Description
63:48	SysRetSel: SYSRET CS and SS. Read-write.
47:32	SysCallSel: SYSCALL CS and SS. Read-write.
31:0	Target: SYSCALL target address. Read-write.

MSRC000_0082 Long Mode SYSCALL Target Address (STAR64)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	LSTAR: long mode target address. Read-write. Target address for 64-bit mode calling programs. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs).

MSRC000_0083 Compatibility Mode SYSCALL Target Address (STARCOMPAT)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	CSTAR: compatibility mode target address. Read-write. Target address for compatibility mode. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs).

MSRC000_0084 SYSCALL Flag Mask (SYSCALL_FLAG_MASK)

Bits	Description
63:32	RAZ.
31:0	Mask: SYSCALL flag mask. Read-write. Reset: 0000_0000h. This register holds the EFLAGS mask used by the SYSCALL instruction. 1=Clear the corresponding EFLAGS bit when executing the SYSCALL instruction.

MSRC000_0100 FS Base (FS_BASE)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	FSBase: expanded FS segment base. Read-write; not-same-for-all. This register provides access to the expanded 64-bit FS segment base. The address stored in this register must be in canonical form (if not canonical, a #GP fault fill occurs).

MSRC000_0101 GS Base (GS_BASE)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	GSBase: expanded GS segment base. Read-write; not-same-for-all. This register provides access to the expanded 64-bit GS segment base. The address stored in this register must be in canonical form (if not canonical, a #GP fault fill occurs).

MSRC000_0102 Kernel GS Base (KernelGSbase)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	KernelGSBase: kernel data structure pointer. Read-write. This register holds the kernel data structure pointer which can be swapped with the GS_BASE register using the SwapGS instruction. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs).

MSRC000_0103 Auxiliary Time Stamp Counter (TSC_AUX)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:32	Reserved.
31:0	TscAux: auxiliary time stamp counter data. Read-write. It is expected that this is initialized by privileged software to a meaningful value, such as a processor ID. This value is returned in the RDTSCP instruction.

MSRC000_0104 Time Stamp Counter Ratio (TscRateMsr)

[MSRC000_0104 \[Time Stamp Counter Ratio \(TscRateMsr\)\]](#) allows the hypervisor to control the guest's view of the Time Stamp Counter. It provides a multiplier that scales the value returned when [MSR0000_0010\[TSC\]](#) and [MSR0000_00E7\[MPERF\]](#) are read by a guest running under virtualization. This allows the hypervisor to provide a consistent TSC and MPERF rate for a guest process when moving that process between cores that have a differing P0 rate. The TSC Ratio MSR does not affect the value read from the TSC and MPERF MSRs when read when in host mode or when virtualization is not being used or when accessed by code executed in system management mode (SMM) unless the SMM code is executed within a guest container. The TSC Ratio value does not affect the rate of the underlying TSC and MPERF counters, or the value that gets written to the TSC and MPERF MSRs counters on a write by either the host or the guest. The TSC Ratio MSR contains a fixed-point number in 8.32 format, which is 8 bits of integer and 32 bits of fraction. This number is the ratio of the desired P0 frequency to the P0 frequency of the core. The reset value of the TSC Ratio MSR is 1.0, which results in a guest frequency matches the core P0 frequency.

Bits	Description
63:40	MBZ.
39:32	TscRateMsrInt: time stamp counter rate integer. Read-write. Reset: 01h. Specifies the integer part of the MSR TSC ratio value.
31:0	TscRateMsrFrac: time stamp counter rate fraction. Read-write. Reset: 0000_0000h. Specifies the fractional part of the MSR TSC ratio value.

MSRC000_0408 NB Machine Check Misc 4 (Link Thresholding) 1 (MC4_MISC1)

Per-node. [MSRC000_0408](#) is associated with the link error type. See [2.16.1.7 \[Error Thresholding\]](#). Accessibility of this register by non-NBC cores is affected by [D18F3x44\[NbMcaToMstCpuEn\]](#).

Bits	Description
63	Valid. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 1. ENDIF. 1=The CntP field is present.
62	CntP: counter present. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 1. ENDIF. 1=A valid threshold counter is present.
61	Locked. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node ; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; Per-node ; not-same-for-all. ELSE Read-only; Per-node ; not-same-for-all. Reset: 0. ENDIF. BIOS: IF (IntType==10b) THEN 1. ELSE 0. ENDIF. 1=Writes to bits [55:32] of this register are ignored. Set by BIOS to indicate that this register is not available for OS use. When MSRC001_0015[McStatusWrEn] is set, MSR writes to this register update all bits, regardless of the state of the Locked bit.

60:56	Reserved.										
55:52	<p>LvtOffset: LVT offset. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~MSRC000_0408[Locked]) THEN Read-write; Per-node; not-same-for-all. ELSE Read-only; Per-node; not-same-for-all. Reset: 0h. ENDIF. Specifies the address of the LVT entry in the APIC registers as follows: LVT address = (LvtOffset shifted left 4 bits) + 500h (see APIC[530:500]).</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>See APIC[530:500].</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Description	3h-0h	See APIC[530:500].	Fh-4h	Reserved				
Bits	Description										
3h-0h	See APIC[530:500].										
Fh-4h	Reserved										
51	<p>CntEn: counter enable. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~Locked) THEN Read-write; Per-node; not-same-for-all. ELSE Read-only; Per-node; not-same-for-all. Reset: 0. ENDIF. 1=Count thresholding errors. See 2.16.1.7 [Error Thresholding].</p>										
50:49	<p>IntType: interrupt type. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~MSRC000_0408[Locked]) THEN Read-write; Per-node; not-same-for-all. ELSE Read-only; Per-node; not-same-for-all. Cold reset: 0. ENDIF. Specifies the type of interrupt signaled when Ovrflw is set.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No Interrupt.</td></tr> <tr> <td>01b</td><td>APIC. APIC based interrupt (see LvtOffset above) to all cores.</td></tr> <tr> <td>10b</td><td>SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.8.2.3 [SMI Sources And Delivery].</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	No Interrupt.	01b	APIC. APIC based interrupt (see LvtOffset above) to all cores.	10b	SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.8.2.3 [SMI Sources And Delivery].	11b	Reserved
Bits	Description										
00b	No Interrupt.										
01b	APIC. APIC based interrupt (see LvtOffset above) to all cores.										
10b	SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.8.2.3 [SMI Sources And Delivery].										
11b	Reserved										
48	<p>Ovrflw: overflow. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~Locked) THEN Read-write; Per-node; not-same-for-all; set-by-hardware. ELSE Read-only; Per-node; not-same-for-all; set-by-hardware. Cold reset: 0. ENDIF. Set by hardware when ErrCnt transitions from FFEh to FFFh. When this bit is set, the interrupt selected by the IntType field is generated.</p>										
47:44	Reserved.										
43:32	<p>ErrCnt: error counter. IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSEIF (MSRC001_0015[McStatusWrEn] ~Locked) THEN Read-write; Per-node; not-same-for-all; updated-by-hardware. ELSE Read-only; Per-node; not-same-for-all; updated-by-hardware. Cold reset: 0. ENDIF. Written by software to set the starting value of the error counter. Incremented by hardware when errors are logged. Saturates at FFFh (no rollover). The threshold value, written by software, is (FFFh - the desired error count (the number of errors necessary in order for an interrupt to be taken)).</p>										
31:0	Reserved.										

MSRC000_0409 Reserved

Bits	Description
63:0	RAZ.

MSRC000_040[F:A] Reserved

Bits	Description
63:0	RAZ.

3.21 MSRs - MSRC001_0xxx

MSRC001_00[03:00] Performance Event Select (PERF_CTL[3:0])

Reset: 0000_0000_0000_0000h. See 2.6.1 [Performance Monitor Counters].

Table 241: Register Mapping for MSRC001_00[03:00]

Register	Function
MSRC001_0000	Counter 0
MSRC001_0001	Counter 1
MSRC001_0002	Counter 2
MSRC001_0003	Counter 3

Bits	Description										
63:42	Reserved.										
41	HostOnly: host only counter. Read-write. 1=Events are only counted when the processor is in host mode.										
40	GuestOnly: guest only counter. Read-write. 1=Events are only counted when the processor is in guest mode.										
39:36	Reserved.										
35:32	EventSelect[11:8]: performance event select. Read-write. See: EventSelect[7:0].										
31:24	<p>CntMask: counter mask. Read-write. Controls the number of events counted per clock cycle.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>The corresponding PERF_CTR[3:0] register is incremented by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 3.</td></tr> <tr> <td>03h-01h</td><td>When Inv = 0, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.</td></tr> <tr> <td></td><td>When Inv = 1, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is less than CntMask value.</td></tr> <tr> <td>FFh-04h</td><td>Reserved.</td></tr> </table>	Bits	Definition	00h	The corresponding PERF_CTR[3:0] register is incremented by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 3.	03h-01h	When Inv = 0, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.		When Inv = 1, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is less than CntMask value.	FFh-04h	Reserved.
Bits	Definition										
00h	The corresponding PERF_CTR[3:0] register is incremented by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 3.										
03h-01h	When Inv = 0, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.										
	When Inv = 1, the corresponding PERF_CTR[3:0] register is incremented by 1 if the number of events occurring in a clock cycle is less than CntMask value.										
FFh-04h	Reserved.										
23	Inv: invert counter mask. Read-write. See CntMask.										
22	En: enable performance counter. Read-write. 1= Performance event counter is enabled.										
21	Reserved.										
20	Int: enable APIC interrupt. Read-write. 1=APIC performance counter LVT interrupt is enabled to generate an interrupt when the performance counter overflows.										
19	Reserved.										
18	Edge: edge detect. Read-write. 0=Level detect. 1=Edge detect. The edge count mode increments the counter when a transition happens on the monitored event. If the event selected is changed without disabling the counter, an extra edge is falsely detected when the first event is a static 0 and the second event is a static one. To avoid this false edge detection, disable the counter when changing the event and then enable the counter with a second MSR write.										
17	OS: OS mode. Read-write. 1=Events are only counted when CPL=0.										
16	User: user mode. Read-write. 1=Events only counted when CPL>0.										

15:8	UnitMask: event qualification. Read-write. Each UnitMask bit further specifies or qualifies the event specified by EventSelect. All events selected by UnitMask are simultaneously monitored. Unless otherwise stated, the UnitMask values shown may be combined (logically ORed) to select any desired combination of the sub-events for a given event. In some cases, certain combinations can result in misleading counts, or the UnitMask value is an ordinal rather than a bit mask. These situations are described where applicable, or should be obvious from the event descriptions. For events where no UnitMask table is shown, the UnitMask is not applicable and may be set to zeros.
7:0	EventSelect[7:0]: event select. Read-write. This field, along with EventSelect[11:8] above, combine to form the 12-bit event select field, EventSelect[11:0]. EventSelect specifies the event or event duration in a processor unit to be counted by the corresponding PERF_CNT[3:0] register. The events are specified in section 3.23 [Core Performance Counter Events]. Some events are reserved; when a reserved event is selected, the results are undefined.

MSRC001_00[07:04] Performance Event Counter (PERF_CTR[3:0])

The core provides four 48-bit performance counters. Each counter can monitor a different event specified by MSRC001_00[03:00] [Performance Event Select (PERF_CTL[3:0])]. The accuracy of the counters is not ensured.

Performance counters are used to count specific processor events, such as data-cache misses, or the duration of events, such as the number of clocks it takes to return data from memory after a cache miss. During event counting, the processor increments the counter when it detects an occurrence of the event. During duration measurement, the processor counts the number of processor clocks it takes to complete an event. Each performance counter can be used to count one event, or measure the duration of one event at a time.

In addition to the RDMSR instruction, the PERF_CNT[3:0] registers can be read using a special read performance-monitoring counter instruction, RDPMC. The RDPMC instruction loads the contents of the PERF_CTR[3:0] register specified by the ECX register, into the EDX register and the EAX register.

Writing the performance counters can be useful if there is an intention for software to count a specific number of events, and then trigger an interrupt when that count is reached. An interrupt can be triggered when a performance counter overflows. Software should use the WRMSR instruction to load the count as a two's-complement negative number into the performance counter. This causes the counter to overflow after counting the appropriate number of times.

The performance counters are not assured of producing identical measurements each time they are used to measure a particular instruction sequence, and they should not be used to take measurements of very small instruction sequences. The RDPMC instruction is not serializing, and it can be executed out-of-order with respect to other instructions around it. Even when bound by serializing instructions, the system environment at the time the instruction is executed can cause events to be counted before the counter value is loaded into EDX:EAX.

Table 242: Register Mapping for MSRC001_00[07:04]

Register	Function
MSRC001_0004	Counter 0
MSRC001_0005	Counter 1
MSRC001_0006	Counter 2
MSRC001_0007	Counter 3

Bits	Description
63:48	RAZ.
47:0	CTR: performance counter value. Read-write. Reset: 0. Returns the current value of the event counter.

MSRC001_0010 System Configuration (SYS_CFG)

Bits	Description
63:23	Reserved.
22	Tom2ForceMemTypeWB: top of memory 2 memory type write back. Read-write. Reset: 0. 1=The default memory type of memory between 4GB and TOM2 is write back instead of the memory type defined by MSR0000_02FF [MemType]. For this bit to have any effect, MSR0000_02FF [MtrrDefTypeEn] must be 1. MTRRs and PAT can be used to override this memory type.
21	MtrrTom2En: MTRR top of memory 2 enable. Read-write. Reset: 0. 0= MSRC001_001D [Top Of Memory 2 (TOM2)] is disabled. 1=This register is enabled. See D0F0x64_x19 [TomEn].
20	MtrrVarDramEn: MTRR variable DRAM enable. Read-write. Reset: 0. BIOS: 1. 0= MSRC001_001A [Top Of Memory (TOP_MEM)] and IORRs are disabled. 1=These registers are enabled.
19	MtrrFixDramModEn: MTRR fixed RdDram and WrDram modification enable. Read-write. Reset: 0. Controls access to MSR0000_02[6F:68,59:58,50] [RdDram, WrDram]. 0=Access type is MBZ; writing 00b does not change the hidden value of MSR0000_02[6F:68,59:58,50] [RdDram, WrDram]. 1=Access type is Read-write. BIOS: This bit should be set to 1 during BIOS initialization of the fixed MTRRs, then cleared to 0 for operation.
18	MtrrFixDramEn: MTRR fixed RdDram and WrDram attributes enable. Read-write. Reset: 0. BIOS: 1. 1=Enables the RdDram and WrDram attributes in MSR0000_02[6F:68,59:58,50] .
17	SysUcLockEn: system lock command enable. Read-write. Reset: 1. 0=Coherent fabric does not support bus lock transactions. This bit must be set on multi-core processors.
16	Reserved.
15:0	Reserved.

MSRC001_0015 Hardware Configuration (HWCR)

Bits	Description
63:32	Reserved.
31:30	Reserved.

29	CSEnable: connected standby enable. Read-write. Reset: 0. 0=Connected standby feature is disabled. No Local APIC writes to NB PCI space or C6 save space will occur on C6 entry. No Local APIC restore from C6 save space will occur on C6 exit. No C6 state save skip will occur. 1=Connected standby feature is enabled. Local APIC writes to NB PCI Space and C6 save space can occur if MSR0000_001B[ApicEn] is set. Local APIC restore from C6 save space on C6 exit can occur if MSR0000_001B[ApicEn] .
28	Reserved.
27	Reserved.
26	EffFreqCntMwait: effective frequency counting during mwait. Read-write. Reset: 0. Specifies whether MSR0000_00E7 [Max Performance Frequency Clock Count (MPERF)] and MSR0000_00E8 [Actual Performance Frequency Clock Count (APERF)] increment while the core is in the monitor event pending state. 0=The registers do not increment. 1=The registers increment. See 2.5.3.3 [Effective Frequency] .
25	CpbDis: core performance boost disable. Read-write. Reset: 0. Specifies whether core performance boost is requested to be enabled or disabled. 0=CPB is requested to be enabled. 1=CPB is disabled. See 2.5.9 [Application Power Management (APM)] . If core performance boost is disabled while a core is in a boosted P-state, the core will automatically transition to the highest performance non-boosted P-state.
24	TscFreqSel: TSC frequency select. Read-only. Reset: 1. 1=The TSC increments at the P0 frequency. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering] .
23	ForceRdWrSzPrb: force probes for RdSized and WrSized. Read-write. Reset: 0. A read returns a 1 if this field is set on any core of the node. 1=Forces probes on read-sized and write-sized transactions, except those that are display refresh.
22	Reserved.
21	MisAlignSseDis: misaligned SSE mode disable. Read-write. Reset: 0. 1=Disables misaligned SSE mode. If this is set, then CPUID Fn8000_0001_ECX[MisAlignSse] is 0.
20	IoCfgGpFault: IO-space configuration causes a GP fault. Read-write. Reset: 0. 1=IO-space accesses to configuration space cause a GP fault. The fault is triggered if any part of the IO read/write address range is between CF8h and CFFh, inclusive. These faults only result from single IO instructions, not to string and REP IO instructions. This fault takes priority over the IO trap mechanism described by MSRC001_0054 [IO Trap Control (SMI_ON_IO_TRAP_CTL_STS)] .
19	Reserved.
18	McStatusWrEn: machine check status write enable. Read-write. Reset: 0. McStatusWrEn can be used to debug machine check exception and interrupt handlers. See 2.16.3 [Error Injection and Simulation] . See 2.16.1 [Machine Check Architecture] . <ul style="list-style-type: none"> • 1=Writes by software to MCi_STATUS (see 2.16.1 [Machine Check Architecture]) do not cause general protection faults; such writes update all implemented bits in these registers. • 0=MCi_STATUS registers are readable; writing a non-zero pattern to these registers causes a general protection fault. • The MCi_STATUS registers are: MSR0000_0401, MSR0000_0405, MSR0000_0409, MSR0000_040D, MSR0000_0411, MSR0000_0415. McStatusWrEn does not affect the writability of MSR0000_0001; MSR0000_0001 is always writable.

17	Wrap32Dis: 32-bit address wrap disable. Read-write. Reset: 0. 1=Disable 32-bit address wrapping. Software can use Wrap32Dis to access physical memory above 4 Gbytes without switching into 64-bit mode. To do so, software should write a greater-than 4 Gbyte address to MSRC000_0100 [FS Base (FS_BASE)] and MSRC000_0101 [GS Base (GS_BASE)] . Then it would address ± 2 Gbytes from one of those bases using normal memory reference instructions with a FS or GS override prefix. However, the INVLPG, FST, and SSE store instructions generate 32-bit addresses in legacy mode, regardless of the state of Wrap32Dis.
16:15	Reserved.
14	RsmSpCycDis: RSM special bus cycle disable. IF MSRC001_0015[SmmLock] THEN Read-only ELSE Read-write ENDIF. Reset: 0. 0=A link special bus cycle, SMIACK, is generated on a resume from SMI.
13	SmiSpCycDis: SMI special bus cycle disable. IF MSRC001_0015[SmmLock] THEN Read-only ELSE Read-write ENDIF. Reset: 0. 0=A link special bus cycle, SMIACK, is generated when an SMI interrupt is taken.
12	Reserved.
11	Reserved.
10	MonMwaitUserEn: MONITOR/MWAIT user mode enable. Read-write. Reset: 0. 1=The MONITOR and MWAIT instructions are supported in all privilege levels. 0=The MONITOR and MWAIT instructions are supported only in privilege level 0; these instructions in privilege levels 1 to 3 cause a #UD exception. The state of this bit is ignored if MonMwaitDis is set.
9	MonMwaitDis: MONITOR and MWAIT disable. Read-write. Reset: 0. 1=The MONITOR and MWAIT opcodes become invalid. This affects what is reported back through CPUID Fn0000_0001_ECX[Monitor] .
8	IgnneEm: IGNNE port emulation enable. Read-write. Reset: 0. 1=Enable emulation of IGNNE port.
7:6	Reserved.
5	Reserved.
4	INVDWBINVD: INVD to WBINVD conversion. Read-write. Reset: 0. 1=Convert INVD to WBINVD. BIOS: See 2.3.3 [Using L2 Cache as General Storage During Boot] . This bit is required to be set for normal operation when two or more cores of a L2 complex are enabled, and thus share the L2 cache.
3	TlbCacheDis: cacheable memory disable. Read-write. Reset: 0. 1=Disable performance improvement that assumes that the PML4, PDP, PDE and PTE entries are in cacheable WB DRAM. Operating systems that maintain page tables in any other memory type must set the TlbCacheDis bit to insure proper operation. <ul style="list-style-type: none"> TlbCacheDis does not override the memory type specified by the SMM ASeg and TSeg memory regions. See 2.4.8.2.7 [The Protected ASeg and TSeg Areas].
2	Reserved.
1	Reserved.
0	SmmLock: SMM code lock. Read; write-1-only. Reset: 0. SBIOS: 1. 1=SMM code in the ASeg and TSeg range and the SMM registers are read-only and SMI interrupts are not intercepted in SVM. See 2.4.8.2.9 [Locking SMM] .

MSRC001_00[18,16] IO Range Base (IORR_BASE[1:0])

Reset: 0000_0000_0000_0000h. MSRC001_0016 and MSRC001_0017 combine to specify the first IORR range and MSRC001_0018 and MSRC001_0019 combine to specify the second IORR range. A core access, with address CPUAddr, is determined to be within IORR address range if the following equation is true: CPUAddr[39:12] & PhyMask[39:12] == PhyBase[39:12] & PhyMask[39:12].

BIOS can use the IORRs to create an IO hole within a range of addresses that would normally be mapped to DRAM. It can also use the IORRs to re-assert a DRAM destination for a range of addresses that fall within a bigger IO hole that overlays DRAM. See [2.4.6.1.2 \[Determining The Access Destination for Core Accesses\]](#).

Bits	Description
63:40	RAZ.
39:12	PhyBase: physical base address. Read-write.
11:5	RAZ.
4	RdMem: read from memory. Read-write. 1=Read accesses to the range are directed to system memory. 0=Read accesses to the range are directed to IO.
3	WrMem: write to memory. Read-write. 1=Write accesses to the range are directed to system memory. 0=Write accesses to the range are directed to IO.
2:0	RAZ.

MSRC001_00[19,17] IO Range Mask (IORR_MASK[1:0])

Reset: 0000_0000_0000_0000h. See [MSRC001_00\[18,16\]](#).

Bits	Description
63:40	RAZ.
39:12	PhyMask: physical address mask. Read-write.
11	Valid. Read-write. 1=The pair of registers that specifies an IORR range is valid.
10:0	RAZ.

MSRC001_001A Top Of Memory (TOP_MEM)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:40	RAZ.
39:23	TOM[39:23]: top of memory. Read-write. Specifies the address that divides between MMIO and DRAM. This value is normally placed below 4G. From TOM to 4G is MMIO; below TOM is DRAM. See 2.4.6 [System Address Map] and 2.9.11 [DRAM CC6/PC6 Storage] .
22:0	RAZ.

MSRC001_001D Top Of Memory 2 (TOM2)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:40	RAZ.
39:23	TOM2[39:23]: second top of memory. Read-write. Specifies the address divides between MMIO and DRAM. This value is normally placed above 4G. From 4G to TOM2 - 1 is DRAM; TOM2 and above is MMIO. See 2.4.6 [System Address Map] and 2.9.11 [DRAM CC6/PC6 Storage] . This register is enabled by MSRC001_0010[MtrrTom2En] .
22:0	RAZ.

MSRC001_001F Northbridge Configuration 1 (NB_CFG1)

Read-write; **Per-node**. Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#). [MSRC001_001F\[31:0\]](#) is an alias of [D18F3x88](#). [MSRC001_001F\[63:32\]](#) is an alias of [D18F3x8C](#).

Bits	Description
63	Reserved.
62	DisStpClkAbortFlush. Reset: 0. BIOS: 1. 1=Disable aborting flush for core when the other core has a pending architectural interrupt.
61:56	Reserved.
55	EnaDiv1CpuLowPwr. Reset: 0. BIOS: 1. Enables power management actions in the core even when the requested clock divisor is /1. Normally a /1 clock divisor does not generate power management actions.
54	InitApicIdCpuIdLo. Reset: 0. BIOS: 1. 0=Reserved. 1=Selects the format for ApicId; see APIC20 .
53:52	Reserved.
51	DisDatFwdVic. Reset: 0. BIOS: 1. 1=Disables data forwarding from victims to reads.
50	DisOrderRdRsp. Reset: 0. 1=Disables ordered responses to IO link read requests.
49:47	Reserved.
46	EnableCf8ExtCfg: enable CF8 extended configuration cycles. Reset: 0. 1=Allows the IO configuration space access method, IOCF8 and IOCF8C , to be used to generate extended configuration cycles by enabling IOCF8[27:24] .
45	DisUsSysMgtReqToNcHt: disable upstream system management request to link. Reset: 0. 1=Disables downstream reflection of upstream STPCLK and x86 legacy input system management commands (in order to work around potential deadlock scenarios related to reflection regions).
44:37	Reserved.

36	DisDatMsk: disable data mask. Reset: 0. BIOS: IF (DataMaskMbType !=1) THEN 1 ELSE 0 ENDIF. 1=Disables DRAM data masking function; all write requests that are less than one cacheline, a DRAM read is performed before writing the data. Data masking is supported in ECC mode; the NB performs a minimum write size of 16B.
35:32	Reserved.
31	DisCohLdtCfg: disable coherent link configuration accesses. Reset: 0. 1=Disables automatic routing of PCI configuration accesses to the processor configuration registers; PCI configuration space accesses which fall within the hard-coded range reserved for processor configuration-space registers are instead routed to the IO link specified by D18F1x[1DC:1D0,EC:E0] [Configuration Map]. This can be used to effectively hide the configuration registers from software. It can also be used to provide a means for an external chip to route processor configuration accesses according to a scheme other than the hard-coded version. When used, this bit needs to be set on all processors in a system. PCI configuration accesses should not be generated if this bit is not set on all processors.
30:28	Reserved.
27	DisDramScrub. Reset: 0. 1=Disable DRAM ECC scrubbing; this overrides the settings in D18F3x58 [Scrub Rate Control], D18F3x5C [DRAM Scrub Address Low].
26:19	Reserved.
18	DisCstateBoostBlockPstateUp. Read-write. Reset: 0. BIOS: 1. 1=Allow cores that are waking up out of a non-C0 C-state to transition to the last requested Pstate without having to wait for cores in the boosted P-state to transition out of the boosted P-state.
17:0	Reserved.

MSRC001_0022 Machine Check Exception Redirection

Reset: 0000_0000_0000_0000h. This register can be used to redirect machine check exceptions (MCEs) to SMIs or vectored interrupts. If both RedirSmiEn and RedirVecEn are set, then undefined behavior results.

Bits	Description
63:32	Reserved.
31:10	Reserved.
9	RedirSmiEn. Read-write. 1=Redirect MCEs (that are directed to this core) to generate an SMI-trigger IO cycle via MSRC001_0056 . The status is stored in SMMFEC4 [MceRedirSts].
8	RedirVecEn. Read-write. 1=Redirect MCEs (that are directed to this core) to generate a vectored interrupt, using the interrupt vector specified in RedirVector.
7:0	RedirVector. Read-write. See RedirVecEn.

MSRC001_00[35:30] Processor Name String

Reset: 0000_0000_0000_0000h. BIOS: [Table 244](#). These registers hold the CPUID name string in ASCII. The state of these registers are returned by CPUID instructions, [CPUID Fn8000_000\[4:2\]_E\[D,C,B,A\]X](#). BIOS should set these registers to the product name for the processor as provided by AMD. Each register contains a block of 8 ASCII characters; the least byte corresponds to the first ASCII character of the block; the most-significant byte corresponds to the last character of the block. MSRC001_0030 contains the first block of the name string; MSRC001_0035 contains the last block of the name string.

Table 243: Register Mapping for MSRC001_00[35:30]

Register	Function
MSRC001_0030	Characters 7-0
MSRC001_0031	Characters 15-8
MSRC001_0032	Characters 23-16
MSRC001_0033	Characters 31-24
MSRC001_0034	Characters 39-32
MSRC001_0035	Characters 47-40

See [D18F5x194](#) for the access method to [D18F5x198_x\[B:0\]](#).

Table 244: BIOS Recommendations for MSRC001_00[35:30]

Register	BIOS
MSRC001_0030	{D18F5x198_x1, D18F5x198_x0}
MSRC001_0031	{D18F5x198_x3, D18F5x198_x2}
MSRC001_0032	{D18F5x198_x5, D18F5x198_x4}
MSRC001_0033	{D18F5x198_x7, D18F5x198_x6}
MSRC001_0034	{D18F5x198_x9, D18F5x198_x8}
MSRC001_0035	{D18F5x198_xB, D18F5x198_xA}

Bits	Description
63:0	CpuNameString . Read-write.

MSRC001_003E Hardware Thermal Control (HTC)

Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#). Uses hardware P-state numbering. See [2.5.3.1.1.2 \[Hardware P-state Numbering\]](#).

Bits	Description
63:32	Reserved.
31	Reserved.
30:28	HtcPstateLimit : HTC P-state limit select. MSRC001_003E[HtcPstateLimit] is an alias of D18F3x64[HtcPstateLimit] . MSRC001_003E[HtcPstateLimit] is an alias of D18F3x64[HtcPstateLimit] .
27:24	HtcHystLmt : HTC hysteresis. MSRC001_003E[HtcHystLmt] is an alias of D18F3x64[HtcHystLmt] .
23	HtcSlewSel : HTC slew-controlled temperature select. MSRC001_003E[HtcSlewSel] is an alias of D18F3x64[HtcSlewSel] .

22:16	HtcTmpLmt: HTC temperature limit. MSRC001_003E [HtcTmpLmt] is an alias of D18F3x64 [HtcTmpLmt].
15:8	Reserved.
7	PslApicLoEn: P-state limit lower value change APIC interrupt enable. MSRC001_003E [PslApicLoEn] is an alias of D18F3x64 [PslApicLoEn].
6	PslApicHiEn: P-state limit higher value change APIC interrupt enable. MSRC001_003E [PslApicHiEn] is an alias of D18F3x64 [PslApicHiEn].
5	HtcActSts: HTC-active status. MSRC001_003E [HtcActSts] is an alias of D18F3x64 [HtcActSts].
4	HtcAct: HTC-active state. MSRC001_003E [HtcAct] is an alias of D18F3x64 [HtcAct].
3:1	Reserved.
0	HtcEn: HTC enable. MSRC001_003E [HtcEn] is an alias of D18F3x64 [HtcEn].

MSRC001_0044 DC Machine Check Control Mask (MC0_CTL_MASK)

Read-write. Reset: 0000_0000_0000_0000h. BIOS: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). See [MSR0000_0400 \[MC0 Machine Check Control \(MC0_CTL\)\]](#).

Bits	Description
63:12	Reserved.
11	SRDE_ALLMsk: all system read data errors mask. Read-write. See DDPMsk.
10	SRDETMsk: read data errors on TLB reload mask. Read-write. See DDPMsk.
9	SRDESMsk: read data errors on store mask. Read-write. See DDPMsk.
8	SRDELMsk: read data errors on load mask. Read-write. See DDPMsk.
7	TLB2MMsk: L2DTLB multi-hit mask. Read-write. 1=Disable detection. See DDPMsk.
6	TLB2PMsk: L2DTLB parity mask. Read-write. 1=Disable detection. See DDPMsk.
5	TLB1MMsk: L1DTLB multi-hit mask. Read-write. 1=Disable detection. See DDPMsk.
4	Reserved.
3	DTPMsk: tag array parity errors mask. Read-write. See DDPMsk.
2	DDPMsk: data array parity errors mask. Read-write. 1=Disable error logging in MSR0000_0401 [MC0 Machine Check Status (MC0_STATUS)] and MSR0000_0402 [MC0 Machine Check Address (MC0_ADDR)] for errors represented by this bit. This bit also disables error detection, and prevents error responses. See 2.16.1 [Machine Check Architecture] and MSR0000_0400 [MC0 Machine Check Control (MC0_CTL)] .
1:0	Reserved.

MSRC001_0045 IC Machine Check Control Mask (MC1_CTL_MASK)

Reset: 0000_0000_0000_0000h. BIOS: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). See [MSR0000_0404 \[MC1 Machine Check Control \(MC1_CTL\)\]](#).

Bits	Description
63:10	Reserved.
9	SRDEMsk: read data errors mask. Read-write. See: IDPMsk.
8:7	Reserved.

6	TLBPMsk: TLB parity errors mask. Read-write. See: IDPMsk.
5	Reserved.
4	ISTPMsk: snoop tag array parity errors mask. Read-write. See: IDPMsk.
3	ITPMsk: tag array parity errors mask. Read-write. See: IDPMsk.
2	IDPMsk: data array parity errors mask. Read-write. 1=Disable error logging in MSR0000_0405 [MC1 Machine Check Status (MC1_STATUS)] and MSR0000_0406 [MC1 Machine Check Address (MC1_ADDR)] for errors represented by this bit. This bit also disables error detection, and prevents error responses. See 2.16.1 [Machine Check Architecture] and MSR0000_0404 [MC1 Machine Check Control (MC1_CTL)] .
1	IVPMsk: victim parity error mask. Read-write. 1=Disable logging victim parity errors.
0	PRPEMsk: ME patch RAM parity error mask. Read-write. 1=Disable logging patch ram parity errors.

MSRC001_0046 BU Machine Check Control Mask (MC2_CTL_MASK)

Read-write. Reset: 0000_0000_0000_0000h. BIOS: 0000_0000_0000_0000h. See [2.16.1 \[Machine Check Architecture\]](#). See [MSR0000_0408 \[MC2 Machine Check Control \(MC2_CTL\)\]](#).

Bits	Description
63:14	Reserved.
13	AttrParity: report attribute parity errors.
12:9	Reserved.
8	DataUncor: report uncorrectable data errors.
7	DataCor: report correctable data errors.
6	DataParity: report data parity errors.
5	TagUncor: report uncorrectable tag errors.
4	TagCor: report correctable tag errors.
3	Reserved.
2	NbFill: NB read response error due to a fill.
1	NbRead: NB read response error due to a write/victim.
0	Reserved.

MSRC001_0047 Reserved (MC3_CTL_MASK)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	Reserved.

MSRC001_0048 NB Machine Check Control Mask (MC4_CTL_MASK)

IF ([D18F3x44](#)[NbMcaToMstCpuEn] && !NBC) THEN RAZ. ELSE Read-write; [Per-node](#). ENDIF. The format of MC4_CTL_MASK corresponds to [MSR0000_0410 \[MC4 Machine Check Control \(MC4_CTL\)\]](#). For each defined bit position, 1=Disable logging. Only one of these registers exists in multi-core devices; see

3.1.1 [Northbridge MSRs In Multi-Core Products]. See 2.16.1 [Machine Check Architecture]. Accessibility of this register by non-NBC cores is affected by D18F3x44[NbMcaToMstCpuEn]. See MSR0000_0410 [MC4 Machine Check Control (MC4_CTL)].

Bits	Description
63:32	Reserved.
31	McaCpuDatErrEn. Reset: 0. BIOS: 0.
30	Reserved.
29	UCRCEn. Reset: 0. BIOS: 0.
28	CCRCEn. Reset: 0. BIOS: 0.
27	Reserved.
26	NbArrayParEn. Reset: 1.
25	UsPwDatErrEn. Reset: 0. BIOS: 0.
24:18	Reserved.
17	CpPktDatEn. Reset: 0. BIOS: 0.
16	NbIntProtEn. Reset: 0. BIOS: 0.
15:13	Reserved.
12	WDTRptEn. Reset: 0. BIOS: 0.
11	AtomicRMWEn. Reset: 0. BIOS: 0.
10	Reserved.
9	TgtAbortEn. Reset: 0. BIOS: 0.
8	MstrAbortEn. Reset: 0. BIOS: 0.
7:6	Reserved.
5	SyncPktEn. Reset: 0. BIOS: 0.
4:2	Reserved.
1	UECCEn. Reset: 0. BIOS: 0.
0	CECCEn. Reset: 0. BIOS: 0.

MSRC001_0049 FR Machine Check Control Mask (MC5_CTL_MASK)

Reset: 0000_0000_0000_0000h. BIOS: 0000_0000_0000_0000h. See 2.16.1 [Machine Check Architecture]. See MSR0000_0414 [MC5 Machine Check Control (MC5_CTL)].

Bits	Description
63:1	Reserved.
0	CPUWDTMsk: CPU watchdog timer mask. Read-write. 1=Disable error logging in MSR0000_0415 [MC5 Machine Check Status (MC5_STATUS)] and MSR0000_0416 [MC5 Machine Check Address (MC5_ADDR)] for errors represented by this bit. This bit also disables error detection, and prevents error responses. See 2.16.1 [Machine Check Architecture] and MSR0000_0414 [MC5 Machine Check Control (MC5_CTL)].

MSRC001_00[53:50] IO Trap (SMI_ON_IO_TRAP_[3:0])

Reset: 0000_0000_0000_0000h.

[MSRC001_00\[53:50\]](#) and [MSRC001_0054](#) provide a mechanism for executing the SMI handler if a an access to one of the specified addresses is detected. Access address and access type checking is performed before IO instruction execution. If the access address and access type match one of the specified IO address and access types, then: (1) the IO instruction is not executed; (2) any breakpoint, other than the single-step breakpoint, set on the IO instruction is not taken (the single-step breakpoint is taken after resuming from SMM); and (3) the SMI-trigger IO cycle specified by [MSRC001_0056](#). The status is stored in [SMMFEC4\[IoTrapSts\]](#).

IO-space configuration accesses are special IO accesses. An IO access is defined as an IO-space configuration access when IO instruction address bits[31:0] are CFCh, CFDh, CFEh, or CFFh when IO-space configuration is enabled ([IOCF8\[ConfigEn\]](#)). The access address for a configuration space access is the current value of [IOCF8\[BusNo, Device, Function, RegNo\]](#). The access address for an IO access that is not a configuration access is equivalent to the IO instruction address, bits[31:0].

The access address is compared with [SmiAddr](#), and the instruction access type is compared with the enabled access types defined by [ConfigSMI](#), [SmiOnRdEn](#), and [SmiOnWrEn](#). Access address bits[23:0] can be masked with [SmiMask](#).

IO and configuration space trapping to SMI applies only to single IO instructions; it does not apply to string and REP IO instructions.

The conditional GP fault described by [MSRC001_0015\[IoCfgGpFault\]](#) takes priority over this trap.

Table 245: [Register Mapping](#) for [MSRC001_00\[53:50\]](#)

Register	Function
MSRC001_0050	Range 0
MSRC001_0051	Range 1
MSRC001_0052	Range 2
MSRC001_0053	Range 3

Bits	Description
63	SmiOnRdEn: enable SMI on IO read. Read-write. 1=Enables SMI generation on a read access.
62	SmiOnWrEn: enable SMI on IO write. Read-write. 1=Enables SMI generation on a write access.
61	ConfigSmi: configuration space SMI. Read-write. 1=Configuration access. 0=IO access (that is not an IO-space configuration access).
60:56	Reserved.
55:32	SmiMask[23:0]. Read-write. SMI IO trap mask. 0=Mask address bit. 1=Do not mask address bit.
31:0	SmiAddr[31:0]. Read-write. SMI IO trap address.

[MSRC001_0054 IO Trap Control \(SMI_ON_IO_TRAP_CTL_STS\)](#)

For each of the [SmiEn](#) bits below, 1=The trap specified by the corresponding MSR is enabled. See [MSRC001_00\[53:50\]](#).

Bits	Description
63:32	RAZ.
31:16	Reserved.

15	IoTrapEn: IO trap enable. Read-write. Reset: 0. 1=Enable IO and configuration space trapping specified by MSRC001_00[53:50] and MSRC001_0054 .
14:8	Reserved.
7	SmiEn3: SMI enable for the trap specified by MSRC001_0053. Read-write. Reset: 0.
6	Reserved.
5	SmiEn2: SMI enable for the trap specified by MSRC001_0052. Read-write. Reset: 0.
4	Reserved.
3	SmiEn1: SMI enable for the trap specified by MSRC001_0051. Read-write. Reset: 0.
2	Reserved.
1	SmiEn0: SMI enable for the trap specified by MSRC001_0050. Read-write. Reset: 0.
0	Reserved.

MSRC001_0055 Interrupt Pending

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	RAZ.

MSRC001_0056 SMI Trigger IO Cycle

Not-same-for-all. Reset: 0000_0000_0000_0000h. See [2.4.8.2.3 \[SMI Sources And Delivery\]](#). This register specifies an IO cycle that may be generated when a local SMI trigger event occurs. If IoCycleEn is set and there is a local SMI trigger event, then the IO cycle generated is a byte read or write, based on IoRd, to address IoPortAddress. If the cycle is a write, then IoData contains the data written. If the cycle is a read, the value read is discarded. If IoCycleEn is clear and a local SMI trigger event occurs, then undefined behavior results.

Bits	Description
63:32	Reserved.
31:27	Reserved.
26	IoRd: IO Read. Read-write. 1=IO read; 0=IO write.
25	IoCycleEn: IO cycle enable. Read-write. 1=The SMI trigger IO cycle is enabled to be generated.
24	Reserved.
23:16	IoData. Read-write.
15:0	IoPortAddress. Read-write.

MSRC001_0058 MMIO Configuration Base Address

Same-for-all. See [2.7 \[Configuration Space\]](#) for a description of MMIO configuration space.

Bits	Description
63:40	RAZ.

39:20	MmioCfgBaseAddr[39:20]: MMIO configuration base address bits[39:20]. Read-write. Reset: 0. Specifies the base address of the MMIO configuration range. The size of the MMIO configuration-space address range is specified by BusRange as follows. All lower order undefined bits must be 0.			
	<u>BusRange</u>	<u>MmioCfgBaseAddr</u>	<u>BusRange</u>	<u>MmioCfgBaseAddr</u>
	0h	[39:20]	5h	[39:25]
	1h	[39:21]	6h	[39:26]
	2h	[39:22]	7h	[39:27]
	3h	[39:23]	8h	[39:28]
	4h	[39:24]	Fh-9h	Reserved
19:6	RAZ.			
5:2	BusRange: bus range identifier. Read-write. Reset: 0. Specifies the number of buses in the MMIO configuration space range. The size of the MMIO configuration space is 1 MB times the number of buses.			
	<u>Bits</u>	<u>Description</u>	<u>Bits</u>	<u>Description</u>
	0h	1	5h	32
	1h	2	6h	64
	2h	4	7h	128
	3h	8	8h	256
	4h	16	Fh-9h	Reserved
1	Reserved.			
0	Enable. Read-write. Reset: 0. 1=MMIO configuration space is enabled.			

MSRC001_0060 BIST Results

Read; GP-write. Reset: 0000_0000_xxxx_xxxxh. This register provides BIST results after each reset. The results provided here are identical to the values provided in EAX. If (MSRC001_0060[29:0]=0000_0000h) then no BIST failures were detected.

Bits	Description
63:32	Reserved.
31:0	BistResults.

MSRC001_0061 P-state Current Limit

Read; GP-write; updated-by-hardware. See 2.5.3 [CPU Power Management].

Bits	Description
63:7	RAZ.
6:4	PstateMaxVal: P-state maximum value. Specifies the lowest-performance non-boosted P-state (highest non-boosted value) allowed. Attempts to change MSRC001_0062[PstateCmd] to a lower-performance P-state (higher value) are clipped to the value of this field. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering] .
3	RAZ.
2:0	CurPstateLimit: current P-state limit. Specifies the highest-performance non-boosted P-state (lowest value) allowed. CurPstateLimit is always bounded by MSRC001_0061[PstateMaxVal] . Attempts to change the CurPstateLimit to a value greater (lower performance) than MSRC001_0061[PstateMaxVal] leaves CurPstateLimit unchanged. This field uses software P-state numbering. See MSRC001_0071[CurPstateLimit] and 2.5.3.1.1.1 [Software P-state Numbering] . CurPstateLimit = D18F3x64[HtcPstateLimit] .

MSRC001_0062 P-state Control

Bits	Description
63:3	MBZ.
2:0	PstateCmd: P-state change command. Read-write; Not-same-for-all . Cold reset value varies by product; after a warm reset, value initializes to the P-state the core was in prior to the reset. Writes to this field cause the core to change to the indicated non-boosted P-state number, specified by MSRC001_00[6B:64] . 0=P0, 1=P1, etc. P-state limits are applied to any P-state requests made through this register. Reads from this field return the last written value, regardless of whether any limits are applied. This field uses software P-state numbering. See 2.5.3 [CPU Power Management] and 2.5.3.1.1.1 [Software P-state Numbering] .

MSRC001_0063 P-state Status

Read; GP-write; Updated-by-hardware.

Bits	Description
63:3	RAZ.
2:0	CurPstate: current P-state. Cold reset: Varies by product. This field provides the frequency component of the current non-boosted P-state of the core (regardless of the source of the P-state change, including MSRC001_0062[PstateCmd] ; see 2.5.3.1.5 [Core P-state Transition Behavior] for information on how these interact). 0=P0, 1=P1, etc. The value of this field is updated when the COF transitions to a new value associated with a P-state. This field uses software P-state numbering. See 2.5.3 [CPU Power Management] and 2.5.3.1.1.1 [Software P-state Numbering] .

MSRC001_00[6B:64] P-state [7:0]

Per-node. Cold reset: Varies by product. Each of these registers specify the frequency and voltage associated with each of the core P-states.

Table 246: Register Mapping for MSRC001_00[6B:64]

Register	Function
MSRC001_0064	P-state 0
MSRC001_0065	P-state 1
MSRC001_0066	P-state 2
MSRC001_0067	P-state 3
MSRC001_0068	P-state 4
MSRC001_0069	P-state 5
MSRC001_006A	P-state 6
MSRC001_006B	P-state 7

The CpuVid field in these registers is required to be programmed to the same value in all cores of a processor, but are allowed to be different between processors in a multi-processor system. All other fields in these registers are required to be programmed to the same value in each core of the coherent fabric. See 2.5.3 [CPU Power Management].

When D18F4x15C[BoostLock]=1, MSRC001_00[6B:64][CpuVid, CpuDid, CpuFid] have special write requirements associated with them.

Table 247: P-state Definitions

Term	Definition
CoreCOF	Core current operating frequency in MHz. $\text{CoreCOF} = 100 * (\text{MSRC001_00[6B:64][CpuFid[5:0]]} + 10h) / (2^{\text{MSRC001_00[6B:64][CpuDid]}})$.

Bits	Description										
63	PstateEn. Read-write. 1=The P-state specified by this MSR is valid. 0=The P-state specified by this MSR is not valid. The purpose of this register is to indicate if the rest of the P-state information in the register is valid after a reset; it controls no hardware.										
62:42	RAZ.										
41:40	IddDiv: current divisor. Read-write. See IddValue.										
39:32	IddValue: current value. Read-write. After a reset, IddDiv and IddValue combine to specify the expected maximum current dissipation of a single core that is in the P-state corresponding to the MSR number. These values are intended to be used to create ACPI-defined _PSS objects (see 2.5.3.1.8.3 [ACPI Processor P-state Objects]) and to perform the 2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]. The values are expressed in amps; they are not intended to convey final product power levels; they may not match the power levels specified in the Power and Thermal Datasheets. These fields are encoded as follows: <table> <tr> <th><u>IddDiv</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>IddValue / 1 A, Range: 0 to 255 A.</td></tr> <tr> <td>01b</td><td>IddValue / 10 A, Range: 0 to 25.5 A.</td></tr> <tr> <td>10b</td><td>IddValue / 100 A, Range: 0 to 2.55 A.</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>IddDiv</u>	<u>Description</u>	00b	IddValue / 1 A, Range: 0 to 255 A.	01b	IddValue / 10 A, Range: 0 to 25.5 A.	10b	IddValue / 100 A, Range: 0 to 2.55 A.	11b	Reserved
<u>IddDiv</u>	<u>Description</u>										
00b	IddValue / 1 A, Range: 0 to 255 A.										
01b	IddValue / 10 A, Range: 0 to 25.5 A.										
10b	IddValue / 100 A, Range: 0 to 2.55 A.										
11b	Reserved										
31:23	RAZ.										

22	NbPstate: Northbridge P-state. IF (MSRC001_0071[NbPstateDis]) THEN Read-only. ELSE Read-write. ENDIF. 1=Low performance NB P-state. 0=High performance NB P-state. If this bit is set in any given P-state register, then it must also be set in all enabled lower performance P-state registers as well. Equivalent P-states in each core must program this bit to the same value. See 2.5.4.1 [NB P-states] and D18F5x170[NbPstateThreshold, NbPstateLo, NbPstateHi].														
21	RAZ.														
20:17	RAZ.														
16	CpuVid[7]: core VID bit[7]. Read-write. Except as required by 2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check], software should not modify this field. See CpuVid[6:0].														
15:9	CpuVid[6:0]: core VID. Read-write. Except as required by 2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check], software should not modify this field. See 2.5.1 [Processor Power Planes And Voltage Control].														
8:6	CpuDid: core divisor ID. Read-write. Except as required by 2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check], software should not modify this field. Specifies the core frequency divisor; see CpuFid. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Divide-by 1</td></tr> <tr> <td>1h</td><td>Divide-by 2</td></tr> <tr> <td>2h</td><td>Divide-by 4</td></tr> <tr> <td>3h</td><td>Divide-by 8</td></tr> <tr> <td>4h</td><td>Divide-by 16</td></tr> <tr> <td>7h-5h</td><td>Reserved</td></tr> </table>	Bits	Description	0h	Divide-by 1	1h	Divide-by 2	2h	Divide-by 4	3h	Divide-by 8	4h	Divide-by 16	7h-5h	Reserved
Bits	Description														
0h	Divide-by 1														
1h	Divide-by 2														
2h	Divide-by 4														
3h	Divide-by 8														
4h	Divide-by 16														
7h-5h	Reserved														
5:0	CpuFid[5:0]: core frequency ID. Read-write. Except as required by 2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check], software should not modify this field. Specifies the core frequency multiplier. The core COF is a function of CpuFid and CpuDid, and defined by CoreCOF.														

MSRC001_0070 COFVID Control

Cold reset: Product-specific. There is one register implemented for each core. This register includes several fields that are identical to MSRC001_00[6B:64]. It is controlled by hardware for P-state transitions. It may also be used by software to directly control the current COF or VID.

Accesses to this register that result in invalid COFs or VIDs are ignored. See 2.5.3 [CPU Power Management].

Bits	Description
63:32	RAZ.
31:24	NbVid: Northbridge VID. IF (MSRC001_0071[NbPstateDis]) THEN Read-only. ELSE Read-write. ENDIF. See D18F5x16[C:0][NbVid].
23	RAZ.
22	NbPstate: Northbridge P-state. IF (MSRC001_0071[NbPstateDis]) THEN Read-only. ELSE Read-write. ENDIF. See MSRC001_00[6B:64][NbPstate].

21	RAZ.
20	CpuVid[7] : Read-write. See CpuVid[6:0].
19	RAZ.
18:16	PstateId: P-state identifier . Read-write. This field is required to provide the P-state number that is associated with the values of the other fields in this register. This value is used by the logic to determine if the P-state is increasing or decreasing. This field uses hardware P-state numbering. See 2.5.3.1.1.2 [Hardware P-state Numbering] .
15:9	CpuVid[6:0]: core VID . Read-write. See MSRC001_00[6B:64][CpuVid] . CpuVid[7:0] = {CpuVid[7], CpuVid[6:0]}.
8:6	CpuDid: core divisor ID . Read-write. See MSRC001_00[6B:64][CpuDid] . The PstateId field must be updated to cause a new CpuDid value to take effect.
5:0	CpuFid[5:0]: core frequency ID . Read-write. See MSRC001_00[6B:64][CpuFid] . The PstateId field must be updated to cause a new CpuFid value to take effect.

MSRC001_0071 COFVID Status

See [2.5.3 \[CPU Power Management\]](#).

Bits	Description
63:59	MaxNbCof: maximum NB COF . Read-only. Cold reset: Product-specific. Specifies the maximum NB COF supported by the processor. If MaxNbCof is greater than zero, the maximum frequency is 100 MHz * MaxNbCof; if MaxNbCof = 00h, then there is no frequency limit. Any attempt to change the NB COF to a frequency greater than specified by this field is ignored.
58:56	CurPstateLimit: current P-state limit . Read-only; updated-by-hardware. Provides the current high-performance P-state limit number. This register uses hardware P-state numbering. See MSRC001_0061[CurPstateLimit] and 2.5.3.1.1.2 [Hardware P-state Numbering] .
55	Reserved.
54:49	MaxCpuCof: maximum core COF . Read-only. Cold reset: Product-specific. Specifies the maximum CPU COF supported by the processor. The maximum frequency is 100 MHz * MaxCpuCof, if MaxCpuCof is greater than zero; if MaxCpuCof = 00h, then there is no frequency limit. Any attempt to change a CPU COF to a frequency greater than specified by this field is ignored.
48:35	Reserved.
34:32	StartupPstate: startup P-state number . Read-only. Cold reset: Product-specific. Specifies the cold reset VID, FID and DID for the core based on the P-state number selected. StartupPstate uses hardware P-state numbering. See MSRC001_00[6B:64] and 2.5.3.1.1.2 [Hardware P-state Numbering] .
31:24	CurNbVid[7:0]: current NB VID . Read-only; updated-by-hardware. Cold reset: Product-specific. This field specifies the current VDDNB voltage. MSRC001_0071[CurNbVid[7:0]] is an alias of D18F5x174[CurNbVid[7:0]] .
23	NbPstateDis: NB P-states disabled . Value: D18F5x174[NbPstateDis] . MSRC001_0071[NbPstateDis] is an alias of D18F5x174[NbPstateDis] . 0=NB P-state frequency and voltage changes are supported. See D18F5x170[SwNbPstateLoDis, NbPstateDisOnP0] . 1=NB P-state frequency and voltage changes are disabled.
22	Reserved.

21	Reserved.
20	CurCpuVid[7] . Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. See CurCpuVid[6:0] .
19	Reserved.
18:16	CurPstate: current P-state . Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. Specifies the current P-state requested by the core. This field uses hardware P-state numbering. See MSRC001_0063[CurPstate] and 2.5.3.1.1.2 [Hardware P-state Numbering] . When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed.
15:9	CurCpuVid[6:0]: current core VID . Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. $\text{CurCpuVid} = \{\text{CurCpuVid}[7], \text{CurCpuVid}[6:0]\}$. This field specifies the current VDD voltage.
8:6	CurCpuDid: current core divisor ID . Read-only; updated-by-hardware. Cold reset: Product-specific. Specifies the current CpuDid of the core. See MSRC001_00[6B:64] . When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed.
5:0	CurCpuFid: current core frequency ID . Read-only; updated-by-hardware. Cold reset: Product-specific. Specifies the current CpuFid of the core. See MSRC001_00[6B:64] . When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed.

MSRC001_0073 C-state Base Address

Reset: 0000_0000_0000_0000h.

Bits	Description
63:32	Reserved.
31:16	Reserved.
15:0	CstateAddr: C-state address . Read-write. Specifies the IO addresses trapped by the core for C-state entry requests. A value of 0 in this field specifies that the core does not trap any IO addresses for C-state entry. Writing values greater than FFF8h into this field result in undefined behavior. All other values cause the core to trap IO addresses CstateAddr through CstateAddr+7. See 2.5.3.2.2 [C-state Request Interface] , D18F4x11[C:8] , and D18F4x11C .

MSRC001_0074 CPU Watchdog Timer (CpuWdtCfg)

Read-write; [Same-for-all](#). Reset: 0000_0000_0000_0000h.

The CPU watchdog timer (WDT) is implemented as a counter that counts out the time periods specified. The counter starts counting when CpuWdtEn is set. The counter does not count during halt or stop-grant. It restarts the count each time an operation of an instruction completes. If no operation completes by the specified time period, then a machine check error may be recorded if enabled (see [MSR0000_0414](#) through [MSR0000_0417](#)). If a watchdog timer error overflow occurs ([MSR0000_0415\[Overflow\]](#)), a sync flood can be generated if enabled in [D18F3x180\[SyncFloodOnCpuLeakErr\]](#).

The CPU watchdog timer must be set higher than the NB watchdog timer ([D18F3x44 \[MCA NB Configuration\]](#)) in order to allow remote requests to complete. The CPU watchdog timer must be set the same for all

CPUs in a system.

Bits	Description																												
63:7	Reserved.																												
6:3	<p>CpuWdtCountSel: CPU watchdog timer count select. CpuWdtCountSel and CpuWdtTimeBase together specify the time period required for the WDT to expire. The time period is ((the multiplier specified by CpuWdtCountSel) * (the time base specified by CpuWdtTimeBase)). The actual timeout period may be anywhere from zero to one increments less than the values specified, due to non-deterministic behavior.</p> <table><tr><th><u>Bits</u></th><th><u>Multiplier</u></th><th><u>Bits</u></th><th><u>Multiplier</u></th></tr><tr><td>0h</td><td>4095</td><td>6h</td><td>63</td></tr><tr><td>1h</td><td>2047</td><td>7h</td><td>31</td></tr><tr><td>2h</td><td>1023</td><td>8h</td><td>8191</td></tr><tr><td>3h</td><td>511</td><td>9h</td><td>16383</td></tr><tr><td>4h</td><td>255</td><td>Fh-Ah</td><td>Reserved</td></tr><tr><td>5h</td><td>127</td><td></td><td></td></tr></table>	<u>Bits</u>	<u>Multiplier</u>	<u>Bits</u>	<u>Multiplier</u>	0h	4095	6h	63	1h	2047	7h	31	2h	1023	8h	8191	3h	511	9h	16383	4h	255	Fh-Ah	Reserved	5h	127		
<u>Bits</u>	<u>Multiplier</u>	<u>Bits</u>	<u>Multiplier</u>																										
0h	4095	6h	63																										
1h	2047	7h	31																										
2h	1023	8h	8191																										
3h	511	9h	16383																										
4h	255	Fh-Ah	Reserved																										
5h	127																												
2:1	<p>CpuWdtTimeBase: CPU watchdog timer time base. Specifies the time base for the timeout period specified in CpuWdtCountSel.</p> <table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>1.31 ms</td></tr><tr><td>01b</td><td>1.28 us</td></tr><tr><td>10b</td><td>Reserved</td></tr><tr><td>11b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Description</u>	00b	1.31 ms	01b	1.28 us	10b	Reserved	11b	Reserved																		
<u>Bits</u>	<u>Description</u>																												
00b	1.31 ms																												
01b	1.28 us																												
10b	Reserved																												
11b	Reserved																												
0	<p>CpuWdtEn: CPU watchdog timer enable. 1=The WDT is enabled.</p>																												

MSRC001_007A Compute Unit Power Accumulator

Read-only; updated-by-hardware; [Per-L2](#). Reset: 0.

Bits	Description
63:0	CmpUnitPwrAcc. Specifies the total accumulated power in a compute unit. This field rolls over and does not saturate.

MSRC001_007B Max Compute Unit Power Accumulator

Read-only; updated-by-hardware; [Per-L2](#). Reset: 0.

Bits	Description
63:0	MaxCmpUnitPwrAcc. Specifies the maximum accumulated power in a compute unit.

MSRC001_0111 SMM Base Address (SMM_BASE)

Reset: 0000_0000_0003_0000h. This holds the base of the SMM memory region. The value of this register is stored in the save state on entry into SMM (see [2.4.8.2.5 \[SMM Save State\]](#)) and it is restored on returning from SMM. The 16-bit CS (code segment) selector is loaded with SmmBase[19:4] on entering SMM.

SmmBase[3:0] is required to be 0. The SMM base address can be changed in two ways:

- The SMM base address, at offset FF00h in the SMM state save area, may be changed by the SMI

handler. The RSM instruction updates SmmBase with the new value.

- Normal WRMSR access to this register.

Bits	Description
63:32	Reserved.
31:0	SmmBase. IF MSRC001_0015 [SmmLock] THEN Read-only; Not-same-for-all. ELSE Read-write; Not-same-for-all. ENDIF.

MSRC001_0112 SMM TSeg Base Address (SMMAddr)

Reset: 0000_0000_0000_0000h.

See [2.4.8.2 \[System Management Mode \(SMM\)\]](#) and [2.4.6.1 \[Memory Access to the Physical Address Space\]](#). See [MSRC001_0113](#) for more information about the ASeg and TSeg address ranges.

Each CPU access, directed at CPUAddr, is determined to be in the TSeg range if the following is true:

$\text{CPUAddr}[39:17] \& \text{TSegMask}[39:17] == \text{TSegBase}[39:17] \& \text{TSegMask}[39:17]$.

For example, if TSeg spans 256 KB and starts at the 1 MB address. The [MSRC001_0112](#)[TSegBase] would be set to 0010_0000h and the [MSRC001_0113](#)[TSegMask] to FFFC_0000h (with zeros filling in for bits[16:0]). This results in a TSeg range from 0010_0000 to 0013_FFFFh.

Bits	Description
63:40	Reserved.
39:17	TSegBase[39:17]: TSeg address range base. IF MSRC001_0015 [SmmLock] THEN Read-only ELSE Read-write ENDIF.
16:0	Reserved.

MSRC001_0113 SMM TSeg Mask (SMMMask)

Reset: 0000_0000_0000_0000h. See [2.4.8.2 \[System Management Mode \(SMM\)\]](#).

The ASeg address range is located at a fixed address from A0000h–BFFFFh. The TSeg range is located at a variable base (specified by [MSRC001_0112](#)[TSegBase]) with a variable size (specified by [MSRC001_0113](#)[TSegMask]). These ranges provide a safe location for SMM code and data that is not readily accessible by non-SMM applications. The SMI handler can be located in one of these two ranges, or it can be located outside these ranges. These ranges must never overlap each other.

This register specifies how accesses to the ASeg and TSeg address ranges are controlled as follows:

- If [A,T]Valid=1, then:
 - If in SMM, then:
 - If [A, T]Close=0, then the accesses are directed to DRAM with memory type as specified in [A, T]MTypeDram.
 - If [A, T]Close=1, then instruction accesses are directed to DRAM with memory type as specified in [A, T]MTypeDram and data accesses are directed at MMIO space and with attributes based on [A, T]MTypeIoWc.
 - If not in SMM, then the accesses are directed at MMIO space with attributes based on [A,T]MTypeIoWc.

- See 2.4.6.1.1 [Determining Memory Type].

Bits	Description
63:40	Reserved.
39:17	TSegMask[39:17]: TSeg address range mask. IF MSRC001_0015 [SmmLock] THEN Read-only ELSE Read-write ENDIF. See MSRC001_0112 .
16:15	Reserved.
14:12	TMTypDram: TSeg address range memory type. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the memory type for SMM accesses to the TSeg range that are directed to DRAM. See: Table 216 [Valid Values for Memory Type Definition] .
11	Reserved.
10:8	AMTypDram: ASeg Range Memory Type. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the memory type for SMM accesses to the ASeg range that are directed to DRAM. See: Table 216 [Valid Values for Memory Type Definition] .
7:6	Reserved.
5	TMTypIoWc: non-SMM TSeg address range memory type. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the attribute of TSeg accesses that are directed to MMIO space. 0=UC (uncacheable). 1=WC (write combining).
4	AMTypIoWc: non-SMM ASeg address range memory type. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the attribute of ASeg accesses that are directed to MMIO space. 0=UC (uncacheable). 1=WC (write combining).
3	TClose: send TSeg address range data accesses to MMIO. Read-write. 1=When in SMM, direct data accesses in the TSeg address range to MMIO space. See AClose .
2	AClose: send ASeg address range data accesses to MMIO. Read-write. 1=When in SMM, direct data accesses in the ASeg address range to MMIO space. [A, T]Close allows the SMI handler to access the MMIO space located in the same address region as the [A, T]Seg. When the SMI handler is finished accessing the MMIO space, it must clear the bit. Failure to do so before resuming from SMM causes the CPU to erroneously read the save state from MMIO space.
1	TValid: enable TSeg SMM address range. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. 1=The TSeg address range SMM enabled.
0	AValid: enable ASeg SMM address range. IF MSRC001_0015 [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. 1=The ASeg address range SMM enabled.

MSRC001_0114 Virtual Machine Control (VM_CR)

Bits	Description
63:32	Reserved.
31:5	MBZ.
4	SvmeDisable: SVM disable. See Lock for the access type of this field. Reset: 0. 1= MSRC000_0080 [SVME] is MBZ. 0= MSRC000_0080 [SVME] is read-write. Attempting to set this field when (MSRC000_0080 [SVME]==1) causes a #GP fault, regardless of the state of Lock. See the APM2 section titled “Enabling SVM” for software use of this field.

3	Lock: SVM lock. Read-only; write-1-only; cleared-by-hardware. Reset: 0. See MSRC001_0118 [SvmLockKey] for the condition that causes hardware to clear this field. 1=SvmeDisable is read-only. 0=SvmeDisable is read-write.
2	DisA20m: disable A20 masking. Read-write; set-by-hardware. Reset: 0. 1=Disables A20 masking. This bit is set by hardware when the SKINIT instruction is executed.
1	InterceptInit: intercept INIT. Read-write; set-by-hardware. Reset: 0. This bit controls how INIT is delivered in host mode. This bit is set by hardware when the SKINIT instruction is executed. 0=INIT delivered normally. 1=INIT translated into a SX interrupt.
0	DPD: debug port disable. Read-write; set-by-hardware. Reset: 0. Set by hardware when the SKINIT instruction is executed. This bit controls if debug facilities such as JTAG and HDT have access to the processor state information. 1=HDT is disabled. 0=HDT may be enabled.

MSRC001_0115 IGNNE

Bits	Description
63:32	Reserved.
31:1	MBZ.
0	IGNNE: current IGNNE state. Read-write. Reset: 0. This bit controls the current state of the processor internal IGNNE signal.

MSRC001_0116 SMM Control (SMM_CTL)

IF ([MSRC001_0015](#)[SmmLock]) THEN GP-read-write. ELSE GP-read; write-only. ENDIF.

The bits in this register are processed in the order of: SmmEnter, SmiCycle, SmmDismiss, RsmCycle and SmmExit. However, only the following combination of bits may be set in a single write (all other combinations result in undefined behavior):

- SmmEnter and SmiCycle.
- SmmEnter and SmmDismiss.
- SmmEnter, SmiCycle and SmmDismiss.
- SmmExit and RsmCycle.

Software is responsible for ensuring that SmmEnter and SmmExit operations are properly matched and are not nested.

Bits	Description
63:5	MBZ.
4	RsmCycle: send RSM special cycle. 1=Send a RSM special cycle.
3	SmmExit: exit SMM. 1=Exit SMM.
2	SmiCycle: send SMI special cycle. 1=Send a SMI special cycle.
1	SmmEnter: enter SMM. 1=Enter SMM.
0	SmmDismiss: clear SMI. 1=Clear the SMI pending flag.

MSRC001_0117 Virtual Machine Host Save Physical Address (VM_HSAVE_PA)

Bits	Description
63:40	MBZ.
39:12	VM_HSAVE_PA: physical address of host save area. Read-write. Reset: 0. This register contains the physical address of a 4-KB region where VMRUN saves host state and where vm-exit restores host state from. Writing this register causes a #GP if (FF_FFFF_Fh>=VM_HSAVE_PA>=FD_0000_0h).
11:0	MBZ.

MSRC001_0118 SVM Lock Key

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	SvmLockKey: SVM lock key. RAZ; write. Writes to this register when MSRC001_0114 [Lock]==0 modify SvmLockKey. If ((MSRC001_0114 [Lock]==1) && (SvmLockKey!=0) && (The write value==The value stored in SvmLockKey)) for a write to this register then hardware updates MSRC001_0114 [Lock]=0.

MSRC001_011A Local SMI Status

Reset: 0000_0000_0000_0000h. This registers returns the same information that is returned in [SMMFEC4 \[Local SMI Status\]](#) portion of the SMM save state. The information in this register is only updated when [MSRC001_0116](#)[SmmDismiss] is set by software.

Bits	Description
63:32	Reserved.
31:0	Alias of SMMFEC4 [Local SMI Status] .

MSRC001_0140 OS Visible Work-around MSR0 (OSVW_ID_Length)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:16	Reserved.
15:0	OSVWIdLength: OS visible work-around ID length. Read-write. See the Revision Guide for the definition of this field; see 1.2 [Reference Documents] .

MSRC001_0141 OS Visible Work-around MSR1 (OSVW Status)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	OsvwStatusBits: OS visible work-around status bits. Read-write. See the Revision Guide for the definition of this field; see 1.2 [Reference Documents].

MSRC001_023[6,4,2,0] L2I Performance Event Select (L2I_PERF_CTL[3:0])

Per-L2. Reset: 0000_0000_0000_0000h. See 2.6.1 [Performance Monitor Counters].

Table 248: Register Mapping for MSRC001_023[6,4,2,0]

Register	Function
MSRC001_0230	Counter 0
MSRC001_0232	Counter 1
MSRC001_0234	Counter 2
MSRC001_0236	Counter 3

Bits	Description										
63:60	Reserved.										
59:56	ThreadMask[3:0]. Read-write. 0=Count events from the specified thread. 1=Mask count events from the specified thread. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Thread 0</td></tr> <tr> <td>[1]</td><td>Thread 1</td></tr> <tr> <td>[2]</td><td>Thread 2</td></tr> <tr> <td>[3]</td><td>Thread 3</td></tr> </table>	Bit	Description	[0]	Thread 0	[1]	Thread 1	[2]	Thread 2	[3]	Thread 3
Bit	Description										
[0]	Thread 0										
[1]	Thread 1										
[2]	Thread 2										
[3]	Thread 3										
55:52	Reserved.										
51:48	BankMask[3:0]. Read-write. 0=Count events from the specified bank. 1=Mask count events from the specified bank. <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Bank 0</td></tr> <tr> <td>[1]</td><td>Bank 1</td></tr> <tr> <td>[2]</td><td>Bank 2</td></tr> <tr> <td>[3]</td><td>Bank 3</td></tr> </table>	Bit	Description	[0]	Bank 0	[1]	Bank 1	[2]	Bank 2	[3]	Bank 3
Bit	Description										
[0]	Bank 0										
[1]	Bank 1										
[2]	Bank 2										
[3]	Bank 3										
47:41	Reserved.										
40:37	IntCoreSel: interrupt to core select. Read-write. Specifies the logical core of the L2 complex to direct the interrupt.										
36	IntCoreEn: interrupt to core enable. Read-write. 1=Interrupt to a single core specified by IntCoreSel. 0=Interrupt to all cores.										
35:32	EventSelect[11:8]: performance event select. See: EventSelect[7:0].										

31:24	CntMask: counter mask. Read-write. Controls the number of events counted per clock cycle.
<u>Bits</u>	<u>Description</u>
00h	The corresponding L2I_PERF_CTL[3:0] register increments by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 4.
03h-01h	When Inv = 0, the corresponding L2I_PERF_CTL[3:0] register increments by 1, if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.
	When Inv = 1, the corresponding L2I_PERF_CTL[3:0] register increments by 1, if the number of events occurring in a clock cycle is less than CntMask value.
FFh-04h	Reserved
23	Inv: invert counter mask. Read-write. See CntMask.
22	En: enable performance counter. Read-write. 1= Performance event counter is enabled.
21	Reserved.
20	Int: enable APIC interrupt. Read-write. 1=APIC performance counter LVT interrupt is enabled to generate an interrupt via APIC340 [LVT Performance Monitor] when the performance counter overflows.
19	Reserved.
18:16	Reserved.
15:8	UnitMask: event qualification. Read-write. Each UnitMask bit further specifies or qualifies the event specified by EventSelect. All events selected by UnitMask are simultaneously monitored. Unless otherwise stated, the UnitMask values shown may be combined (logically ORed) to select any desired combination of the sub-events for a given event. In some cases, certain combinations can result in misleading counts, or the UnitMask value is an ordinal rather than a bit mask. These situations are described where applicable, or should be obvious from the event descriptions. For events where no UnitMask table is shown, the UnitMask is Unused .
7:0	EventSelect[7:0]: event select. Read-write. This field, along with EventSelect[11:8] above, combine to form the 12-bit event select field, EventSelect[11:0]. EventSelect specifies the event or event duration in a processor unit to be counted by the corresponding PERF_CNT[3:0] register. The events are specified in section 3.23 [Core Performance Counter Events] . Some events are reserved; when a reserved event is selected, the results are undefined.

MSRC001_023[7,5,3,1] L2I Performance Event Counter (L2I_PERF_CTR[3:0])

Per-L2. See [MSRC001_023\[6,4,2,0\] \[L2I Performance Event Select \(L2I_PERF_CTL\[3:0\]\)\]](#).

Table 249: [Register Mapping](#) for [MSRC001_023\[7,5,3,1\]](#)

Register	Function
MSRC001_0231	Counter 0
MSRC001_0233	Counter 1
MSRC001_0235	Counter 2
MSRC001_0237	Counter 3

Bits	Description
63:48	RAZ.
47:0	CTR: performance counter value. Read-write. Reset: 0.

MSRC001_024[6,4,2,0] Northbridge Performance Event Select (NB_PERF_CTL[3:0])

Per-node. See 2.6.1 [Performance Monitor Counters]. MSRC001_024[6,4,2,0][31:0] is an alias of D18F5x[70,60,50,40]. MSRC001_024[6,4,2,0][63:32] is an alias of D18F5x[74,64,54,44].

Table 250: Register Mapping for MSRC001_024[6,4,2,0]

Register	Function
MSRC001_0240	Counter 0
MSRC001_0242	Counter 1
MSRC001_0244	Counter 2
MSRC001_0246	Counter 3

Note: To get meaningful data, each of the counters should be similarly programmed across events selected.

Bits	Description
63:36	Reserved.
35:32	EventSelect[11:8]: performance event select. Read-write. Reset: 0. See EventSelect[7:0].
31:23	Reserved.
22	En: enable performance counter. Read-write. Reset: 0. 1= Performance event counter is enabled.
21	Reserved.
20	Int: enable APIC interrupt. Read-write. Reset: 0. 1=APIC performance counter LVT interrupt is enabled to generate an interrupt via APIC340 [LVT Performance Monitor] to all local APIC's on this node when the performance counter overflows.
19	Reserved.
18:16	Reserved.
15:8	UnitMask: event qualification. Read-write. Reset: 0. Each UnitMask bit further specifies or qualifies the event specified by EventSelect. All events selected by UnitMask are simultaneously monitored. Unless otherwise stated, the UnitMask values shown may be combined (logically ORed) to select any desired combination of the sub-events for a given event. In some cases, certain combinations can result in misleading counts, or the UnitMask value is an ordinal rather than a bit mask. These situations are described where applicable, or should be obvious from the event descriptions. For events where no UnitMask table is shown, the UnitMask is Unused .
7:0	EventSelect[7:0]: event select. Read-write. Reset: 0. This field, along with EventSelect[11:8] above, combine to form the 12-bit event select field, EventSelect[11:0]. EventSelect specifies the event or event duration in a processor unit to be counted by the corresponding NB_PERF_CTR[3:0] register. The events are specified in 3.25 [NB Performance Counter Events]. Some events are reserved; when a reserved event is selected, the results are undefined.

MSRC001_024[7,5,3,1] Northbridge Performance Event Counter (NB_PERF_CTR[3:0])

Per-node. See MSRC001_024[6,4,2,0] [Northbridge Performance Event Select (NB_PERF_CTL[3:0])].

MSRC001_024[7,5,3,1][31:0] is an alias of D18F5x[78,68,58,48]. MSRC001_024[7,5,3,1][63:32] is an alias of D18F5x[7C,6C,5C,4C].

See 2.6.1.3 [NB Performance Monitor Counters] for proper read sequence.

Table 251: [Register Mapping](#) for MSRC001_024[7,5,3,1]

Register	Function
MSRC001_0241	Counter 0
MSRC001_0243	Counter 1
MSRC001_0245	Counter 2
MSRC001_0247	Counter 3

Bits	Description
63:48	RAZ.
47:32	CTR[47:32]: performance counter value[47:32] . See: CTR[31:0].
31:0	CTR[31:0]: performance counter value[31:0] . Read-write. Reset: 0. CTR[47:0] = {CTR[47:32], CTR[31:0]}. Returns the current value of the event counter.

MSRC001_0280 Performance Time Stamp Counter (CU_PTSC)

Support for [MSRC001_0280 \[Performance Time Stamp Counter \(CU_PTSC\)\]](#) indicated by [CUID Fn8000_0001_ECX](#)[PerfTsc]. The size of PTSC indicated by [CUID Fn8000_0008_ECX](#)[PerfTscSize].

Increments at a 100 MHz rate in all P-states, all C states, S0, or S1. Each core on a node at the same instant in time will vary by +/- 3 100 MHz clocks. The value of PTSC[31:0] will be inserted into each record produced.

Bits	Description
63:40	RAZ.
39:0	PTSC: global timestamp counter . Read-only; updated-by-hardware. Reset: 0.

3.22 MSRs - MSRC001_1xxx

MSRC001_1002 CPUID Features for CPUID Fn0000_0007_E[B,A]X_x0

Read-write. Reset: {CPUID Fn0000_0007_EAX_x0, CPUID Fn0000_0007_EBX_x0}.

MSRC001_1002[63:32] provides back-door control over values read from CPUID Fn0000_0007_EAX_x0;

MSRC001_1002[31:0] provides back-door control over values read from CPUID Fn0000_0007_EBX_x0.

Bits	Description
63:9	Reserved.
8	Reserved.
7	Reserved.
6	Reserved.
5	Reserved.
4	Reserved.
3	BMI1.
2:1	Reserved.
0	Reserved.

MSRC001_1004 CPUID Features (Features)

Read-write. Reset: {CPUID Fn0000_0001_ECX, CPUID Fn0000_0001_EDX}. MSRC001_1004[63:32] provides back-door control over values read from CPUID Fn0000_0001_ECX; MSRC001_1004[31:0] provides back-door control over values read from CPUID Fn0000_0001_EDX.

Bits	Description
63	Reserved.
62	RDRAND.
61	F16C.
60	AVX.
59	OSXSAVE. Modifies CPUID Fn0000_0001_ECX[OSXSAVE] only if CR4[OSXSAVE].
58	XSAVE.
57	AES. Modifies CPUID Fn0000_0001_ECX[AES] only if the reset value is 1 .
56	Reserved.
55	POPCNT.
54	MOVBE.
53	x2APIC.
52	SSE42.
51	SSE41.

50:46	Reserved.
45	CMPXCHG16B.
44:42	Reserved.
41	SSSE3.
40:36	Reserved.
35	Monitor. Modifies CUID Fn0000_0001_ECX [Monitor] only if ~MSRC001_0015 [MonMwaitDis].
34	Reserved.
33	PCLMULQDQ. Modifies CUID Fn0000_0001_ECX [PCLMULQDQ] only if the reset value is 1
32	SSE3.
31:29	Reserved.
28	HTT.
27	Reserved.
26	SSE2.
25	SSE.
24	FXSR.
23	MMX.
22:20	Reserved.
19	CLFSH.
18	Reserved.
17	PSE36.
16	PAT.
15	CMOV.
14	MCA.
13	PGE.
12	MTRR.
11	SysEnterSysExit.
10	Reserved.
9	APIC. Modifies CUID Fn0000_0001_EDX [APIC] only if MSR0000_001B [ApicEn].
8	CMPXCHG8B.
7	MCE.
6	PAE.
5	MSR.
4	TSC.
3	PSE.
2	DE.
1	VME.
0	FPU.

MSRC001_1005 Extended CPUID Features (ExtFeatures)

Read-write. Reset: {[CPUID Fn8000_0001_ECX](#), [CPUID Fn8000_0001_EDX](#)}. [MSRC001_1005](#)[63:32] provides back-door control over values read from [CPUID Fn8000_0001_ECX](#); [MSRC001_1005](#)[31:0] provides back-door control over values read from [CPUID Fn8000_0001_EDX](#).

Bits	Description
63:61	Reserved.
60	PerfCtrExtL2I.
59	PerfTsc.
58	DataBreakpointExtension.
57	Reserved.
56	PerfCtrExtNB.
55	PerfCtrExtCore.
54	TopologyExtensions.
53	TBM.
52	Reserved.
51	NodeId.
50	Reserved.
49	Reserved.
48	FMA4.
47	LWP.
46	Reserved.
45	WDT.
44	SKINIT.
43	XOP.
42	IBS.
41	OSVW.
40	3DNowPrefetch.
39	MisAlignSse.
38	SSE4A.
37	ABM.
36	AltMovCr8.
35	ExtApicSpace.
34	SVM. Modifies CPUID Fn8000_0001_ECX [SVM] only if D18F3xE8 [SvmCapable].
33	CmpLegacy.
32	LahfSahf.
31	3DNow.
30	3DNowExt.
29	LM. Read-write.

28	Reserved.
27	RDTSQP.
26	Page1GB.
25	FFXSR.
24	FXSR.
23	MMX.
22	MmxExt.
21	Reserved.
20	NX.
19:18	Reserved.
17	PSE36.
16	PAT.
15	CMOV.
14	MCA.
13	PGE.
12	MTRR.
11	SysCallSysRet.
10	Reserved.
9	APIC.
8	CMPXCHG8B.
7	MCE.
6	PAE.
5	MSR.
4	TSC.
3	PSE.
2	DE.
1	VME.
0	FPU.

MSRC001_101[B:9] Address Mask For DR[3:1] Breakpoints

Reset: 0000_0000_0000_0000h. Support indicated by [CPUID Fn8000_0001_ECX\[DataBreakpointExtension\]](#). See [MSRC001_1027](#).

Table 252: [Register Mapping](#) for [MSRC001_101\[B:9\]](#)

Register	Function
MSRC001_1019	DR1_ADDR_MASK
MSRC001_101A	DR2_ADDR_MASK
MSRC001_101B	DR3_ADDR_MASK

Table 253: Field Mapping for MSRC001_101[B:9]

Register	Bits
	31:0
MSRC001_1019	DR1
MSRC001_101A	DR2
MSRC001_101B	DR3

Bits	Description
63:32	Reserved.
31:0	AddrMask: mask for DR linear address data breakpoint. Read-write. This field qualifies the DR linear address data breakpoint, allowing the DR[3:1] data breakpoint on a range of addresses in memory. The mask bits are active high; 0=Include bit into address compare; 1=Exclude bit into address compare. AddrMask is always used, and it can be used in conjunction with any debug function that uses DR[3:1]. The legacy DR breakpoint function is provided by AddrMask[31:0]==0000_0000h).

MSRC001_1020 Load-Store Configuration (LS_CFG)

Bits	Description
63:53	Reserved.
52	LsWcPlusFastStringEn. Read-write. Reset: 0. BIOS: 1. 1=Enable string optimization on destination memtype of WC+.
51	LsWcFastStringEn. Read-write. Reset: 0. BIOS: 1. 1=Enable string optimization on destination memtype of WC.
50:45	Reserved.
44:27	Reserved.
26	DisHitCurPageOpt. Read-write. Reset: 0. 1=Disable current table-walk page hit optimization.
25	Reserved.
24	WcPlusEn: write combining plus enable. Read-write. Reset: 0h. BIOS: 1. 0=Memtype WC+ is treated as write protect (WP). 1=Treat WC+ as per APM: loads are not cacheable, stores are coherent WC.
23:0	Reserved.

MSRC001_1021 Instruction Cache Configuration (IC_CFG)

Bits	Description
63:27	Reserved.
26	DIS_WIDEREAD_PWR_SAVE . Read-write; Same-for-all . Reset: 0. 1=Disable wide read power mgmt feature for read accesses to IC data array. See 2.3.4 [Instruction Cache Configuration Register Usage Requirements] .
25:10	Reserved.
9	DisSpecTlbRld . Read-write; Same-for-all . Reset: 0. BIOS: See 2.3.3 [Using L2 Cache as General Storage During Boot] . 1=Disable speculative TLB reloads. See 2.3.4 [Instruction Cache Configuration Register Usage Requirements] .
8:0	Reserved.

MSRC001_1022 Data Cache Configuration (DC_CFG)

Bits	Description
63:14	Reserved.
13	DisHwPf . Read-write. Reset: 0. BIOS: See 2.3.3 . 1=Disable hardware prefetches.
12:5	Reserved.
4	DisSpecTlbWalk . Read-write. Reset: 0. BIOS: See 2.3.3 . 1=Disable speculative table-walks.
3:0	Reserved.

MSRC001_1023 Bus Unit Configuration (BU_CFG)

Bits	Description
63:0	Reserved.

MSRC001_1027 Address Mask For DR0 Breakpoints (DR0_ADDR_MASK)

Reset: 0000_0000_0000_0000h. Support for AddrMaskDR0[31:12] is indicated by [CUID Fn8000_0001_ECX\[DataBreakpointExtension\]](#). See [MSRC001_101\[B:9\]](#).

Bits	Description
63:32	Reserved.
31:0	AddrMaskDR0: mask for DR0 linear address data breakpoint . Read-write. This field qualifies the DR0 linear address data breakpoint, allowing the DR0 data breakpoint on a range of addresses in memory. The mask bits are active high; 0=Include bit into address compare; 1=Exclude bit into address compare. AddrMaskDR0 is always used, and it can be used in conjunction with any debug function that uses DR0. AddrMaskDR0[31:12] is only valid for data breakpoints. The legacy DR0 breakpoint function is provided by AddrMaskDR0[31:0]==0000_0000h).

MSRC001_1028 Floating Point Configuration (FP_CFG)

Bits	Description
63:16	Reserved.
15:8	DiDtCfg . Read-write. Reset: 0. BIOS: D18F3x1FC [DiDtCfg]. FP power management policy.
7:0	Reserved.

MSRC001_102A Bus Unit Configuration 2 (BU_CFG2)

Bits	Description
63:16	Reserved.
15	CILinesToL2Dis . Read-write. Reset: 1. BIOS: See 2.3.3 [Using L2 Cache as General Storage During Boot] . 1=Clean victims and clean forced victims are not sent to the L2.
14:0	Reserved.

MSRC001_1030 IBS Fetch Control (IbsFetchCtl)

Reset: 0000_0000_0000_0000h. See [2.6.2 \[Instruction Based Sampling \(IBS\)\]](#).

The IBS fetch sampling engine is described as follows:

- The periodic fetch counter is an internal 20-bit counter:
 - The periodic fetch counter [19:4] is set to IbsFetchCnt[19:4] and the periodic fetch counter [3:0] is set according to IbsRandEn when IbsFetchEn is changed from 0 to 1.
 - It increments for every fetch cycle that completes when IbsFetchEn=1 and IbsFetchVal=0.
 - The periodic fetch counter is undefined when IbsFetchEn=0 or IbsFetchVal=1.
 - When IbsFetchCnt[19:4] is read it returns the current value of the periodic fetch counter [19:4].
- When the periodic fetch counter reaches {IbsFetchMaxCnt[19:4],0h} and the selected instruction fetch completes or is aborted:
 - IbsFetchVal is set to 1.
 - Drivers can't assume that IbsFetchCnt[19:4] is 0 when IbsFetchVal==1.
 - The status of the operation is written to the IBS fetch registers (this register, [MSRC001_1031](#) and [MSRC001_1032](#)).
 - An interrupt is generated as specified by [MSRC001_103A](#). The interrupt service routine associated with this interrupt is responsible for saving the performance information stored in IBS execution registers.

Bits	Description
63:59	Reserved.
58	Reserved.
57	IbsRandEn: random instruction fetch tagging enable . Read-write. 1=Bits[3:0] of the fetch counter are randomized when IbsFetchEn is set to start the fetch counter. 0=Bits[3:0] of the fetch counter are set to 0h when IbsFetchEn is set to start the fetch counter.
56	IbsL2TlbMiss: instruction cache L2TLB miss . Read-write; set-by-hardware. 1=The instruction fetch missed in the L2 TLB.

55	IbsL1TlbMiss: instruction cache L1TLB miss. Read-write; set-by-hardware. 1=The instruction fetch missed in the L1 TLB.										
54:53	IbsL1TlbPgSz: instruction cache L1TLB page size. Read-write; updated-by-hardware. Indicates the page size of the translation in the L1 TLB. This field is only valid if IbsPhyAddrValid==1. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>4 KB</td></tr> <tr> <td>01b</td><td>2 MB</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Description	00b	4 KB	01b	2 MB	10b	Reserved	11b	Reserved
Bits	Description										
00b	4 KB										
01b	2 MB										
10b	Reserved										
11b	Reserved										
52	IbsPhyAddrValid: instruction fetch physical address valid. Read-write; set-by-hardware. 1=The physical address in MSRC001_1032 and the IbsL1TlbPgSz field are valid for the instruction fetch.										
51	IbsIcMiss: instruction cache miss. Read-write; set-by-hardware. 1=The instruction fetch missed in the instruction cache.										
50	IbsFetchComp: instruction fetch complete. Read-write; set-by-hardware. 1=The instruction fetch completed and the data is available for use by the instruction decoder.										
49	IbsFetchVal: instruction fetch valid. Read-write; set-by-hardware. 1=New instruction fetch data available. When this bit is set, the fetch counter stops counting and an interrupt is generated as specified by MSRC001_103A . This bit must be cleared for the fetch counter to start counting. When clearing this bit, software can write 0000h to IbsFetchCnt[19:4] to start the fetch counter at IbsFetchMaxCnt[19:4].										
48	IbsFetchEn: instruction fetch enable. Read-write. 1=Instruction fetch sampling is enabled.										
47:32	IbsFetchLat: instruction fetch latency. Read-write; set-by-hardware. Indicates the number of clock cycles from when the instruction fetch was initiated to when the data was delivered to the core. If the instruction fetch is abandoned before the fetch completes, this field returns the number of clock cycles from when the instruction fetch was initiated to when the fetch was abandoned.										
31:16	IbsFetchCnt[19:4]. Read-write; updated-by-hardware. Provides read/write access to bits[19:4] of the periodic fetch counter. Programming this field to a value greater than or equal to IbsFetchMaxCnt[19:4] results in undefined behavior.										
15:0	IbsFetchMaxCnt[19:4]. Read-write. Specifies bits[19:4] of the maximum count value of the periodic fetch counter. Programming this field to 0000h and setting IbsFetchEn results in undefined behavior. Bits[3:0] of the maximum count are always 0000b.										

MSRC001_1031 IBS Fetch Linear Address (IbsFetchLinAd)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	IbsFetchLinAd: instruction fetch linear address. Read-write; updated-by-hardware. Provides the linear address in canonical form for the tagged instruction fetch.

MSRC001_1032 IBS Fetch Physical Address (IbsFetchPhysAd)

Reset: 0000_0000_0000_0000h.

Bits	Description
------	-------------

63:40	Reserved.
39:0	IbsFetchPhysAd: instruction fetch physical address. Read-write; updated-by-hardware. Provides the physical address for the tagged instruction fetch. The lower 12 bits are not modified by address translation, so they are always the same as the linear address. This field contains valid data only if MSRC001_1030 [IbsPhyAddrValid] is asserted.

MSRC001_1033 IBS Execution Control (IbsOpCtl)

Reset: 0000_0000_0000_0000h. See [2.6.2 \[Instruction Based Sampling \(IBS\)\]](#).

The IBS execution sampling engine is described as follows for IbsOpCntCtl==1. If IbsOpCntCtl==1n then references to “periodic op counter” mean “periodic cycle counter”.

- The periodic op counter is an internal 27-bit counter:
 - It is set to IbsOpCurCnt[26:0] when IbsOpEn is changed from 0 to 1.
 - It increments every dispatched op when IbsOpEn=1 and IbsOpVal=0.
 - The periodic op counter is undefined when IbsOpEn=0 or IbsOpVal=1.
 - When IbsOpCurCnt[26:0] is read then it returns the current value of the periodic micro-op counter [26:0].
- When the periodic micro-op counter reaches IbsOpMaxCnt:
 - The next dispatched micro-op is tagged if IbsOpCntCtl==1. A valid op in the next dispatched line is tagged if IbsOpCntCtl==0. See IbsOpCntCtl.
 - The periodic micro-op counter [26:7]=0; [6:0] is randomized by hardware.
- The periodic micro-op counter is not modified when a tagged micro-op is flushed.
- When a tagged micro-op is retired:
 - IbsOpVal is set to 1.
 - Drivers can't assume that IbsOpCurCnt is 0 when IbsOpVal==1.
 - The status of the operation is written to the IBS execution registers (this register, [MSRC001_1034](#), [MSRC001_1035](#), [MSRC001_1036](#), [MSRC001_1037](#), [MSRC001_1038](#) and [MSRC001_1039](#)).
 - An interrupt is generated as specified by [MSRC001_103A](#). The interrupt service routine associated with this interrupt is responsible for saving the performance information stored in IBS execution registers.

Bits	Description
63:59	Reserved.
58:32	IbsOpCurCnt[26:0]: periodic op counter current count. Read-write; updated-by-hardware. Returns the current value of the periodic op counter.
31:27	Reserved.
26:20	IbsOpMaxCnt[26:20]: periodic op counter maximum count. Read-write. See IbsOpMaxCnt[19:4].
19	IbsOpCntCtl: periodic op counter count control. Read-write. 1=Count dispatched Micro-ops ; when a roll-over occurs, the counter is preloaded with a pseudorandom 7 bit value between 1 and 127. 0=Count clock cycles; a 1-of-4 round robin counter selects an op in the next dispatch line; if the op pointed to by the round robin counter is invalid, then the next younger valid op is selected.
18	IbsOpVal: micro-op sample valid. Read-write; set-by-hardware. 1=New instruction execution data available; the periodic op counter is disabled from counting. An interrupt may be generated when this bit is set as specified by MSRC001_103A [LvtOffset].
17	IbsOpEn: micro-op sampling enable. Read-write. 1=Instruction execution sampling enabled.

16	Reserved.						
15:0	<p>IbsOpMaxCnt[19:4]: periodic op counter maximum count. Read-write. IbsOpMaxCnt[26:0] = {IbsOpMaxCnt[26:20], IbsOpMaxCnt[19:4], 0000b}. Specifies maximum count value of the periodic op counter. Bits [3:0] of the maximum count are always 0000b.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>001Fh-0000h</td><td>Reserved</td></tr> <tr> <td>FFFFh-0020h</td><td><IbsOpMaxCnt[19:4]*16> Micro-ops</td></tr> </table>	Bits	Description	001Fh-0000h	Reserved	FFFFh-0020h	<IbsOpMaxCnt[19:4]*16> Micro-ops
Bits	Description						
001Fh-0000h	Reserved						
FFFFh-0020h	<IbsOpMaxCnt[19:4]*16> Micro-ops						

MSRC001_1034 IBS Op Logical Address (IbsOpRip)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	IbsOpRip: micro-op linear address. Read-write; updated-by-hardware. Linear address in canonical form for the instruction that contains the tagged micro-op.

MSRC001_1035 IBS Op Data (IbsOpData)

Bits	Description
63:41	Reserved.
40	<p>IbsOpMicrocode. Value: 0. 1=Tagged operation from microcode.</p>
39	<p>IbsOpBrnFuse: fused branch micro-op. Value: 0. 1=Tagged operation was a fused branch micro-op. Support indicated by CPUID Fn8000_001B_EAX[OpBrnFuse].</p>
38	<p>IbsRipInvalid: RIP is invalid. Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation RIP is invalid. Support indicated by CPUID Fn8000_001B_EAX[RipInvalidChk].</p>
37	<p>IbsOpBrnRet: branch micro-op retired. Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that retired.</p>
36	<p>IbsOpBrnMisp: mispredicted branch micro-op. Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that was mispredicted. Qualified by IbsOpBrnRet==1.</p>
35	<p>IbsOpBrnTaken: taken branch micro-op. Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that was taken. Qualified by IbsOpBrnRet==1.</p>
34	<p>IbsOpReturn: return micro-op. Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was return micro-op. Qualified by (IbsOpBrnRet==1).</p>
33:32	Reserved.

31:16	IbsTagToRetCtr: micro-op tag to retire count. Read-write; updated-by-hardware. Reset: 0. This field returns the number of cycles from when the micro-op was tagged to when the micro-op was retired. This field is equal to IbsCompToRetCtr when the tagged micro-op is a NOP.
15:0	IbsCompToRetCtr: micro-op completion to retire count. Read-write; updated-by-hardware. Reset: 0. This field returns the number of cycles from when the micro-op was completed to when the micro-op was retired.

MSRC001_1036 IBS Op Data 2 (IbsOpData2)

Reset: 0000_0000h. Northbridge data is only valid for load operations that miss both the L1 data cache and the L2 cache. If a load operation crosses a cache line boundary, the data returned in this register is the data for the access to the lower cache line.

Bits	Description																		
63:32	Reserved.																		
31:6	Reserved.																		
5	Reserved.																		
4	Reserved.																		
3	Reserved.																		
2:0	NbIbsReqSrc: northbridge IBS request data source. Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No valid status</td></tr> <tr> <td>1h</td><td>Reserved</td></tr> <tr> <td>2h</td><td>Cache: data returned from another compute-unit cache.</td></tr> <tr> <td>3h</td><td>DRAM: data returned from DRAM</td></tr> <tr> <td>4h</td><td>Reserved for remote cache</td></tr> <tr> <td>5h</td><td>Reserved</td></tr> <tr> <td>6h</td><td>Reserved</td></tr> <tr> <td>7h</td><td>Other: data returned from MMIO/Config/PCI/APIC</td></tr> </table>	Bits	Description	0h	No valid status	1h	Reserved	2h	Cache: data returned from another compute-unit cache.	3h	DRAM: data returned from DRAM	4h	Reserved for remote cache	5h	Reserved	6h	Reserved	7h	Other: data returned from MMIO/Config/PCI/APIC
Bits	Description																		
0h	No valid status																		
1h	Reserved																		
2h	Cache: data returned from another compute-unit cache.																		
3h	DRAM: data returned from DRAM																		
4h	Reserved for remote cache																		
5h	Reserved																		
6h	Reserved																		
7h	Other: data returned from MMIO/Config/PCI/APIC																		

MSRC001_1037 IBS Op Data 3 (IbsOpData3)

Reset: 0000_0000_0000_0000h. If a load or store operation crosses a 128-bit boundary, the data returned in this register is the data for the access to the data below the 128-bit boundary.

Bits	Description
63:48	IbsTlbRefillLat: L1 DTLB refill latency. Read-only. Value: 0. The number of cycles from when a L1 DTLB refill is triggered by a tagged op to when the L1 DTLB fill has been completed.

47:32	IbsDcMissLat: data cache miss latency. Read-write; updated-by-hardware. Indicates the number of clock cycles from when a miss is detected in the data cache to when the data was delivered to the core. The value returned by this counter is not valid for data cache writes or prefetch instructions.																
31:26	IbsOpDcMissOpenMemReqs: outstanding memory requests on DC fill. Read-only. Value: 0. The number of allocated, valid DC MABs when the MAB corresponding to a tagged DC miss op is deallocated. Includes the MAB allocated by the sampled op. 00000b=No information provided.																
25:22	IbsOpMemWidth: load/store size in bytes. Read-only. Value: 0. Report the number of bytes the load or store is attempting to access. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No information provided.</td></tr> <tr> <td>1h</td><td>Byte</td></tr> <tr> <td>2h</td><td>Word</td></tr> <tr> <td>3h</td><td>DW</td></tr> <tr> <td>4h</td><td>QW</td></tr> <tr> <td>5h</td><td>OW</td></tr> <tr> <td>Fh-6h</td><td>Reserved</td></tr> </table>	Bits	Description	0h	No information provided.	1h	Byte	2h	Word	3h	DW	4h	QW	5h	OW	Fh-6h	Reserved
Bits	Description																
0h	No information provided.																
1h	Byte																
2h	Word																
3h	DW																
4h	QW																
5h	OW																
Fh-6h	Reserved																
21	IbsSwPf: software prefetch. Read-only. Value: 0. 1=The op is a software prefetch.																
20	IbsL2Miss: L2 cache miss for the sampled operation. Read-only. Value: 0. 1=The operation missed in the L2, regardless of whether the op initiated the request to the L2.																
19	IbsDcL2TlbHit1G: data cache L2TLB hit in 1G page. Read-only. Value: 0. 1=The physical address for the tagged load or store operation was present in a 1G page table entry in the data cache L2TLB.																
18	IbsDcPhyAddrValid: data cache physical address valid. Read-write; updated-by-hardware. 1=The physical address in MSRC001_1039 is valid for the load or store operation.																
17	IbsDcLinAddrValid: data cache linear address valid. Read-write; updated-by-hardware. 1=The linear address in MSRC001_1038 is valid for the load or store operation.																
16	DcMissNoMabAlloc: DC miss with no MAB allocated. Read-write; updated-by-hardware. 1=The tagged load or store operation hit on an already allocated MAB.																
15	IbsDcLockedOp: locked operation. Read-write; updated-by-hardware. 1=Tagged load or store operation is a locked operation.																
14	IbsDcUcMemAcc: UC memory access. Read-write; updated-by-hardware. 1=Tagged load or store operation accessed uncacheable memory.																
13	IbsDcWcMemAcc: WC memory access. Read-write; updated-by-hardware. 1=Tagged load or store operation accessed write combining memory.																
12	Reserved.																
11	IbsDcStToLdFwd: data forwarded from store to load operation. Read-write; updated-by-hardware. 1=Data for tagged load operation was forwarded from a store operation. If this bit is set and IbsDcStToLdCan=1, then the data for the load operation forwarded from a store operation but the data was not forwarded immediately.																

10	Reserved.
9	Reserved.
8	IbsDcMisAcc: misaligned access. Read-write; updated-by-hardware. 1=The tagged load or store operation crosses a 128 bit address boundary.
7	IbsDcMiss: data cache miss. Read-write; updated-by-hardware. 1=The cache line used by the tagged load or store was not present in the data cache.
6	IbsDcL2tlbHit2M: data cache L2TLB hit in 2M page. Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was present in a 2M page table entry in the data cache L2TLB.
5	Reserved.
4	IbsDcL1TlbHit2M: data cache L1TLB hit in 2M page. Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was present in a 2M page table entry in the data cache L1TLB.
3	IbsDcL2TlbMiss: data cache L2TLB miss. Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was not present in the data cache L2TLB.
2	IbsDcL1tlbMiss: data cache L1TLB miss. Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was not present in the data cache L1TLB.
1	IbsStOp: store op. Read-write; updated-by-hardware. 1=Tagged operation is a store operation.
0	IbsLdOp: load op. Read-write; updated-by-hardware. 1=Tagged operation is a load operation.

MSRC001_1038 IBS DC Linear Address (IbsDcLinAd)

Reset: 0000_0000_0000_0000h.

Bits	Description
63:0	IbsDcLinAd. Read-write; updated-by-hardware. Provides the linear address in canonical form for the tagged load or store operation. This field contains valid data only if MSRC001_1037 [IbsDcLinAddrValid] is asserted.

MSRC001_1039 IBS DC Physical Address (IbsDcPhysAd)

Bits	Description
63:40	RAZ.
39:0	IbsDcPhysAd: load or store physical address. Read-write; updated-by-hardware. Reset: 0. Provides the physical address for the tagged load or store operation. The lower 12 bits are not modified by address translation, so they are always the same as the linear address. This field contains valid data only if MSRC001_1037 [IbsDcPhyAddrValid] is asserted.

MSRC001_103A IBS Control

GP-write.

Bits	Description
63:32	Reserved.
31:9	Reserved.
8	LvtOffsetVal: local vector table offset valid. MSRC001_103A [LvtOffsetVal] is an alias of D18F3x1CC [LvtOffsetVal].
7:4	Reserved.
3:0	LvtOffset: local vector table offset. MSRC001_103A [LvtOffset] is an alias of D18F3x1CC [LvtOffset].

MSRC001_103B IBS Branch Target Address (BP_IBSTGT_RIP)

Reset: 0000_0000_0000_0000h. Support for this register indicated by [CPUID Fn8000_001B_EAX](#)[BrnTrgt].

Bits	Description
63:0	IbsBrTarget. Read-write; updated-by-hardware. The logical address in canonical form for the branch target. Contains a valid target if non-0. Qualified by MSRC001_1035 [IbsOpBrnRet]==1.

MSRC001_1090 Processor Feedback Constants 0

Read-write.

Bits	Description
63:32	Reserved.
31:16	Reserved.
15:8	RefCountScale. Reset: Product-specific. BIOS: 64h.
7:0	ActualCountScale. Reset: Product-specific. BIOS: A5h.

MSRC001_10A0 L2I Configuration (L2I_CFG)

[Per-L2.](#)

Bits	Description				
63:57	Reserved.				
56:45	L2ScrubberInterval: L2 background scrubber interval [11:0]. Read-write. Reset: 0. BIOS: 100h. If (L2ScrubberDis==0), the background error scrubber will wake up and perform one scrub every (N+1)*64 clock CClks. <table><tr><td><u>Bits</u></td><td><u>Scrubber Interval</u></td></tr><tr><td>FFh-00h</td><td><L2ScrubberInterval>+1) * 64 CClks</td></tr></table>	<u>Bits</u>	<u>Scrubber Interval</u>	FFh-00h	<L2ScrubberInterval>+1) * 64 CClks
<u>Bits</u>	<u>Scrubber Interval</u>				
FFh-00h	<L2ScrubberInterval>+1) * 64 CClks				
44	PbDisObeyThrottleNb: probes disobey NB throttling. Read-write. Reset: 0. BIOS: 1. 1=Probe responses do not obey the ThrottleNbInterface field, but can be sent to the NB on any valid CClk.				

43:40	<p>ThrottleNbInterface: NB Interface Request Throttling [3:0]. Read-write. Reset: Fh. BIOS: NumOfL2Complexes-1. If (PbDisObeyThrottleNb==1), Specifies how many clocks the CU needs to wait before sending the next packet of information to the NB. This applies to the CU->NB request interface and the CU->NB probe response interface.</p> <p>This field must be programmed to a value greater than or equal to the number of L2 complexes in the node that have at least one enabled core minus 1. See 2.4.4 [Processor Cores and Downcoring].</p> <p>If (PbDisObeyThrottleNb==0), probe responses must also obey the same throttling rule.</p> <table> <tr> <td><u>Bits</u></td><td><u>Throttling Interval</u></td></tr> <tr> <td>Fh-0h</td><td><ThrottleNbInterface>+1 CClks</td></tr> </table>	<u>Bits</u>	<u>Throttling Interval</u>	Fh-0h	<ThrottleNbInterface>+1 CClks
<u>Bits</u>	<u>Throttling Interval</u>				
Fh-0h	<ThrottleNbInterface>+1 CClks				
39:22	Reserved.				
21	L2ScrubberDis: L2 Scrubber Disable . Read-write. Reset: 0. 1=Do not search for and repair single bit errors in the background.				
20	<p>L2RinserDis: L2 rinser disable. Read-write. Reset: 0.</p> <p>BIOS: 1.</p> <p>1=Disable background copy of dirty lines to the NB. See L2RinserInterval.</p>				
19	<p>McaToMstCoreEn: route machine check events to master Core. Read-write. Reset: 0. BIOS: 1.</p> <p>1=Errors are logged and reported to the L2 complex Master Core, which is the lowest physically numbered core in the L2 complex that is not fused off.</p> <p>0=Errors are logged and reported to the core whose behavior triggered the error, if that can be determined. If it cannot be determined (e.g. for NB probes) then they are logged and reported to the L2 complex Master Core.</p>				
18:8	Reserved.				
7	PrefetcherDis . Read-write. Reset: 0. BIOS: See 2.3.3 [Using L2 Cache as General Storage During Boot] . 1=Disable the L2 prefetcher.				
6:4	Reserved.				
3	CacheIcAttrDis . Read-write. Reset: 0. BIOS: See 2.3.3 [Using L2 Cache as General Storage During Boot] . 1=Disable inserting IC attributes into the L2.				
2:0	Reserved.				

3.23 Core Performance Counter Events

This section provides the performance counter events that may be selected through [MSRC001_00\[03:00\]\[EventSelect,UnitMask\]](#). See [MSRC001_00\[03:00\]](#) and [MSRC001_00\[07:04\] \[Performance Event Counter \(PERF_CTR\[3:0\]\)\]](#).

For L2I performance counter events see [2.6.1.2 \[L2I Performance Monitor Counters\]](#) and [3.24 \[L2I Performance Counter Events\]](#).

For NB performance counter events see [2.6.1.3 \[NB Performance Monitor Counters\]](#) and [3.25 \[NB Performance Counter Events\]](#).

3.23.1 PMCx0[1F:00] Events (FP)

PMCx000 Dispatched FPU Operations

The number of operations (uops) dispatched to the FPU execution pipelines. This includes all operations done by x87, MMX™ and SSE instructions, including moves. This event is a speculative event. (See PMCx0CB). Since this event includes non-numeric operations it is not suitable for measuring MFLOPs.

UnitMask	Description
7:2	Reserved.
1	Pipe1 dispatches.
0	Pipe0 dispatches.

PMCx001 FP Scheduler Empty

The number of cycles in which the FPU is empty. Invert this ([MSRC001_00\[03:00\]\[Inv\]==1](#)) to count cycles in which at least one FPU operation is present in the FPU.

PMCx002 Dispatched Fast Flag FPU Operations

The number of FPU operations that use the fast flag interface (e.g. FCOMI, COMISS, COMISD, UCOMISS, UCOMISD, MOVD, CVTSD2SI). This event is a speculative event.

PMCx003 Retired SSE/AVX Operations

The number of SSE/AVX operations retired. The number of events logged per cycle can vary from 0 to 8.

UnitMask	Description
7	Reserved.
6	Double precision divide/square root FLOPS.
5	Double precision multiply FLOPS.
4	Double precision add/subtract FLOPS.
3	Reserved.
2	Single-precision divide/square root FLOPS.
1	Single-precision multiply FLOPS.

0	Single-precision add/subtract FLOPS.
---	--------------------------------------

PMCx005 Retired Serializing Ops

The number of serializing uops retired. A bottom-executing uop is not issued until it is the oldest non-retired uop in the FPU. A control-renaming uop requires a rename from a limited pool of control renames.

UnitMask	Description
7:4	Reserved.
3	x87 control-renaming uops retired.
2	x87 bottom-executing uops retired.
1	SSE control-renaming uops retired.
0	SSE bottom-executing uops retired.

PMCx011 Retired x87 Floating Point Operations

The number of x87 floating point ops that have retired.

UnitMask	Description
7:3	Reserved.
2	Divide and fsqrt ops.
1	Multiply ops.
0	Add/subtract ops.

3.23.2 PMCx0[3F:20] Events (LS)

PMCx020 Segment Register Loads

The number of segment register loads performed.

UnitMask	Description
7	Reserved.
6	HS
5	GS
4	FS
3	DS
2	SS
1	CS
0	ES

PMCx021 Pipeline Restart Due to Self-Modifying Code

The number of pipeline restarts that were caused by self-modifying code (a store that hits any instruction that's been fetched for execution beyond the instruction doing the store).

PMCx022 Pipeline Restart Due to Probe Hit

The number of pipeline restarts caused by invalidating probes that hit load out-of-order with respect to other load.

UnitMask	Description
7:2	Reserved.
1	Restarts due to evictions caused by fills.
0	Restarts due to evictions caused by invalidating probes.

PMCx024 Locked Operations

This event covers locked operations performed and their execution time. The execution time represented by the cycle counts is typically overlapped to a large extent with other instructions. The non-speculative cycles event is suitable for event-based profiling of lock operations that tend to miss in the cache.

UnitMask	Description
7:3	Reserved.
2	The number of cycles to unlock \$line (not including cache miss)
1	The number cycles to acquire bus lock
0	The number of locked instructions executed

PMCx026 Retired CLFLUSH Instructions

The number of CLFLUSH instructions retired.

PMCx027 Retired CPUID Instructions

The number of CPUID instructions retired.

PMCx029 LS Dispatch

Counts the number of transactions dispatched to load-store unit.

UnitMask	Description
7:3	Reserved.
2	Load-op-Stores.
1	Stores.
0	Loads.

PMCx02A Canceled Store to Load Forward Operations

Counts the number of missed store to load forward opportunities which resulted in blocks.

UnitMask	Description
7:3	Reserved.

2	Block due to store being misaligned.
1	Block due to store being smaller than the load.
0	Block due to address mismatch (starting byte not the same).

3.23.3 PMCx0[5F:40] Events (DC)

PMCx040 Data Cache Accesses

The number of accesses to the data cache for load and store references. This may include certain microcode scratchpad accesses, although these are generally rare. Each increment represents an eight-byte access, although the instruction may only be accessing a portion of that. This event is a speculative event.

PMCx041 Data Cache Misses

The number of data cache references which miss in the data cache and allocate a MAB. This event is a speculative event.

PMCx042 Data Cache Refills from L2 or Northbridge

The number of data cache refills satisfied from the L2 cache (and/or the northbridge), per the UnitMask. The UnitMask selects lines in one or more specific coherency states. Each increment reflects a 64-byte transfer. If UnitMask[0] is selected it might be less than 64-bytes. This event is a speculative event.

UnitMask	Description
7:5	Reserved.
4	Modified
3	Owned
2	Exclusive
1	Shared
0	Non-cacheable return of data.

PMCx043 Data Cache Refills from the northbridge

The number of L1 cache refills satisfied from the northbridge (DRAM or another processor's cache), as opposed to the L2. The UnitMask selects lines in one or more specific coherency states. Each increment reflects a 64-byte transfer. This event is a speculative event.

UnitMask	Description
7:5	Reserved.
4	Modified
3	Owned
2	Exclusive
1	Shared
0	Non-cacheable read data.

PMCx044 Data Cache Lines Evicted

The UnitMask may be used to count only victims in specific coherency states. Each increment represents a 64-byte transfer. Lines brought into the data cache by PrefetchNTA instructions are evicted directly to system memory (if dirty) or invalidated (if clean). This event is a speculative event.

UnitMask	Description
7:5	Reserved.
4	Modified eviction
3	Owned eviction
2	Exclusive eviction
1	Shared eviction
0	Evicted from probe

PMCx045 L1 DTLB Miss and L2 DTLB Hit

The number of data cache accesses that miss in the L1 DTLB and hit in the L2 DTLB. This event is a speculative event.

PMCx046 DTLB Miss

The number of data cache accesses that miss in both the L1 and L2 DTLBs. This event is a speculative event.

UnitMask	Description
7:4	Reserved.
3	Count loads that miss L2TLB.
2	Count stores that miss L2TLB.
1	Count loads that miss L1TLB.
0	Count stores that miss L1TLB.

PMCx047 Misaligned Accesses

The number of data cache accesses that are misaligned. These are accesses which cross the boundary as specified by UnitMask. Misaligned accesses incur at least an extra cache access and an extra cycle of latency on reads. This event is a speculative event.

UnitMask	Description
7:2	Reserved.
1	Number of misaligns that cross a 4kb boundary
0	Number of misaligns that cross a 16-byte boundary

PMCx04B Prefetch Instructions Dispatched

The number of cycles in which one or two prefetch instructions are dispatched by the decoder. Such instructions may or may not cause a cache line transfer. All Dcache and L2 accesses, hits and misses by prefetch instructions, except for prefetch instructions that collide with an outstanding hardware prefetch, are included in

these events. This event is a speculative event.

UnitMask	Description
7:3	Reserved.
2	NTA (PrefetchNTA)
1	Store (PrefetchW)
0	Load (Prefetch, PrefetchT0/T1/T2)

PMCx04C DCACHE Misses by Locked Instructions

The number of cacheable locked operations that miss in the data cache. Cacheable locks are defined as locks that hit write back memory space and are not misaligned.

PMCx04D L1 DTLB Hit

The number of data cache accesses that hit in the L1 DTLB. This event is a speculative event.

UnitMask	Description
7:2	Reserved.
1	L1 2M TLB hit
0	L1 4K TLB hit

PMCx052 Ineffective Software Prefetchs

The number of software prefetches that do not cause an actual data cache refill. The unit mask may be used to determine the specific cause.

UnitMask	Description
7:4	Reserved.
3	SW Prefetch hit in L2.
2	SW prefetches that don't get a MAB and don't cause PMCx052[1,0] .
1	Software prefetch hit a pending fill.
0	Software prefetch hit in the data cache.

PMCx054 Global Page Invalidations

This event counts TLB flushes that flush TLB entries that have the global bit set.

3.23.4 PMCx[8,1:0][7F:60] Events (BU)

PMCx062 Command Related to Read Block Operations

UnitMask	Description
7	Reserved.
6	Read Block Speculative Shared.

5	RdBlkSpecMod.
4	RdBlkSpec.
3	Reserved.
2	Read Block Shared.
1	RdBlkMod.
0	Read Block.

PMCx063 Command Related to Change to Dirty Operations

UnitMask	Description
7:5	Reserved.
4	Change to Dirty.
3:0	Reserved.

PMCx065 Memory Requests by Type

These events reflect accesses to memory of each region type (as defined by MTRR or PAT settings). UnitMask[1] and UnitMask[7] reflect full 64 byte writes or full or partial 32 byte writes. This counter does not count IcFetches to WC+ memtype. To count WC+ memtype fetches please follow the steps below.

1. Set [PMCx061](#)[5,4,1:0]. This includes all uncacheable memory and IO accesses.
2. Set [PMCx062](#)[6,4,2:0], All Read Block operations
3. Set [PMCx063](#)[4], Change to Dirty.
4. Set [PMCx065](#)[6:3,1,0] to add up all requests by mem type.
5. Sum the count values of [PMCx061](#), [PMCx062](#), and [PMCx063](#) to yield all request by command type.
6. Subtract from the count value of [PMCx065](#) to obtain WC+ memtype accesses.

UnitMask	Description
7	Streaming store (SS) requests.
6:2	Reserved.
1	Request to write-combining (WC) memory.
0	Requests to non-cacheable (UC) memory.

PMCx067 Data Cache Prefetches

UnitMask	Description
7:4	Reserved.
3	Prefetch hits on MAB.
2	Reserved.
1	Prefetch attempts.
0	Reserved.

PMCx068 MAB Requests

These events reflect utilization of the Miss Address Buffers (MABs), which handle L1 cache misses. The UnitMask is an encoded value which selects one of the IC or DC miss buffers. EventSelect 68h counts the number of misses handled by the selected MAB; EventSelect 69h counts the number of cycles the selected MAB is busy waiting for the refill response.

When used together, these two events provide a measure of the average refill latency seen by the selected MAB, which is the number of cycles spent waiting (EventSelect 69h) divided by the number of requests (EventSelect 68h). This calculation gives the most direct indication of average system latency for Dcache and Icache refills, respectively. For other entries this value typically includes queuing delays caused by resource contention with prior refills.

UnitMask	Description												
7:0	BufferN. where N = 00h to 0Ch. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>07h-00h</td><td>DC miss buffers 0 to 7</td></tr> <tr> <td>0Ah-08h</td><td>IC miss buffers 0 to 2</td></tr> <tr> <td>0Bh</td><td>Any DC miss buffer</td></tr> <tr> <td>0Ch</td><td>Any IC miss buffer</td></tr> <tr> <td>FFh-0Dh</td><td>Reserved</td></tr> </table>	Bits	Definition	07h-00h	DC miss buffers 0 to 7	0Ah-08h	IC miss buffers 0 to 2	0Bh	Any DC miss buffer	0Ch	Any IC miss buffer	FFh-0Dh	Reserved
Bits	Definition												
07h-00h	DC miss buffers 0 to 7												
0Ah-08h	IC miss buffers 0 to 2												
0Bh	Any DC miss buffer												
0Ch	Any IC miss buffer												
FFh-0Dh	Reserved												

PMCx069 MAB Wait Cycles

See [PMCx068](#).

UnitMask	Description
7:0	BufferID. See: PMCx068 [BufferN].

PMCx06C System Response by Coherence State

The number of responses from the L2I for cache refill requests. The UnitMask may be used to select specific cache coherency states. Each of {Exclusive, Modified, Shared} represents one 64-byte cache line transferred from the L2I (DRAM, L2 cache, or the L1 cache of another core) to the data cache or instruction cache.

- Modified responses may be for Dcache store miss refills, PrefetchW software prefetches, or Change-to-Dirty requests that get a dirty probe hit in another cache.
- Exclusive responses may be for:
 - Dcache load miss refill.
 - Software prefetches.
- Shared responses may be for:
 - Icache refill.
 - Any request that hits a clean line in another cache.
- Change-to-Dirty success response is for a Dcache upgrade request (store hit to a shared line).
- Uncacheable response is for all uncacheable system requests.

UnitMask	Description
7	Reserved.

6	Uncacheable.
5	Change-to-Dirty success.
4	Data Error.
3	Owned.
2	Shared.
1	Modified.
0	Exclusive.

PMCx06D Data Written to System

The number of 16-byte data transfers from the processor to the system. Note that a dirty cache line writeback would cause four increments. An IO write would cause two increments: one for the mask and one for the data.

UnitMask	Description
7:6	Reserved.
5	Data for Write Combine context flush.
4	Byte Enable Mask for Write Combine context flush.
3	Data for uncacheable or IO store.
2	Byte Enable Mask for uncacheable or IO store.
1	Instruction attribute evictions.
0	Data line evictions.

PMCx075 Cache Cross-invalidates

These reflect internal probes for Icache or Dcache misses that hit in the Dcache or Icache, causing the line to be invalidated. These may result from code modification, data being located too close to code, or virtual address aliasing. The aliasing cases arise when a physical memory location is referenced via two or more virtual addresses which differ in bits 14:12. Such aliasing cases are generally uncommon.

UnitMask	Description
7	Reserved.
6	DC probe rejected late.
5	DC probe rejected early.
4	IC hits DC Clean Line (reading code).
3	IC Invalidates DC Dirty Line (execution of recently modified code, or modified data too close to code).
2	IC Invalidates IC (aliasing).
1	DC Invalidates DC (CD or WBINVD).
0	DC Invalidates IC (modification of cached instructions, or of data located too close to code).

PMCx076 CPU Clocks not Halted

The number of clocks that the CPU is not in a halted state (due to STPCLK or a HLT instruction). Note: this

event allows system idle time to be automatically factored out from IPC (or CPI) measurements, providing the OS halts the CPU when going idle. If the OS goes into an idle loop rather than halting, such calculations are influenced by the IPC of the idle loop.

PMCx07D: Reserved. See [L2IPMCx07D \[Requests to L2 Cache\]](#).

PMCx07E: Reserved. See [L2IPMCx07E \[L2 Cache Misses\]](#).

PMCx07F: Reserved. See [L2IPMCx07F \[L2 Fill/Writeback\]](#).

PMCx162 PDC Miss

Counts the number of PDC miss events specified by the UnitMask.

UnitMask	Description
7	Reserved.
6	Guest: PML4E Level.
5	Guest: PDPE Level.
4	Guest: PDE Level.
3	Reserved.
2	Host: PML4E Level.
1	Host: PDPE Level.
0	Host: PDE Level.

3.23.5 PMCx[1:0][9F:80] Events (IC)

Note: All instruction cache events are speculative events unless specified otherwise.

PMCx080 Instruction Cache Fetches

The number of successful instruction cache accesses by the instruction fetcher that result in data being sent to the decoder. Each access is an aligned 32 byte read, from which a varying number of instructions may be decoded.

PMCx081 Instruction Cache Misses

The number of instruction fetches and prefetch requests that miss in the instruction cache. This is typically equal to or very close to the sum of events 82h and 83h. Each miss results in a 64-byte cache line refill.

PMCx082 Instruction Cache Refills from L2

The number of instruction cache refills satisfied from the L2 cache. Each increment represents one 64-byte cache line transfer.

PMCx083 Instruction Cache Refills from System

The number of instruction cache refills from system memory (or another cache). Each increment represents one 64-byte cache line transfer.

PMCx084 L1 ITLB Miss, L2 ITLB Hit

The number of instruction fetches that miss in the L1 ITLB but hit in the L2 ITLB.

PMCx085 ITLB Miss

The number of instruction fetches that miss in the 4K ITLB and 2M ITLB.

UnitMask	Description
7:2	Reserved.
1	Instruction fetches to a 2M page.
0	Instruction fetches to a 4K page.

PMCx087 Instruction Fetch Stall

The number of cycles the instruction fetcher is stalled. This may be for a variety of reasons such as branch predictor updates, unconditional branch bubbles, far jumps and cache misses, among others. May be overlapped by instruction dispatch stalls or instruction execution, such that these stalls don't necessarily impact performance.

PMCx088 Return Stack Hits

The number of near return instructions (RET or RET Iw) that get their return address from the return address stack (i.e. where the stack has not gone empty). This may include cases where the address is incorrect (return mispredicts). This may also include speculatively executed false-path returns. Return mispredicts are typically caused by the return address stack underflowing, however they may also be caused by an imbalance in calls vs. returns, such as doing a call but then popping the return address off the stack.

This event cannot be reliably compared with events C9h and CAh (such as to calculate percentage of return mispredicts due to an empty return address stack), since it may include speculatively executed false-path returns that are not included in those retire-time events.

PMCx089 Return Stack Overflows

The number of (near) call instructions that cause the return address stack to overflow. When this happens, the oldest entry is discarded. This count may include speculatively executed calls.

PMCx08B Instruction Cache Victims

The number of cachelines evicted from the instruction cache to the L2.

PMCx08C Instruction Cache Lines Invalidated

The number of instruction cache lines invalidated.

UnitMask	Description
7:2	Reserved.
1	IC invalidate due to a BU probe.

0	IC invalidate due to an LS probe.
---	-----------------------------------

PMCx099 ITLB Reloads

The number of ITLB reload requests.

PMCx09A ITLB Reloads Aborted

The number of ITLB reloads aborted.

PMCx19A Retired Indirect Branch Info

UnitMask	Description
7:2	Reserved.
1	Retired Mispredicted Indirect Branch Instruction. Retired Mispredicted Near Unconditional jump with target specified in Register or Memory. This event is non-speculative.
0	Retired Indirect branch Instruction. Retired Near Unconditional jump with target specified in Register or Memory. This event is non-speculative.

3.23.6 PMCx[1,0][DF:C0] Events (EX, DE)

PMCx0C0 Retired Instructions

The number of instructions retired (execution completed and architectural state updated). This count includes exceptions and interrupts - each exception or interrupt is counted as one instruction.

PMCx0C1 Retired uops

The number of micro-ops retired. This includes all processor activity (instructions, exceptions, interrupts, microcode assists, etc.).

PMCx0C2 Retired Branch Instructions

The number of branch instructions retired. This includes all types of architectural control flow changes, including exceptions and interrupts.

PMCx0C3 Retired Mispredicted Branch Instructions

The number of branch instructions retired, of any type, that were not correctly predicted in either target or direction. This includes those for which prediction is not attempted (far control transfers, exceptions and interrupts), and excludes resyncs.

PMCx0C4 Retired Taken Branch Instructions

The number of taken branches that were retired. This includes all types of architectural control flow changes, including exceptions and interrupts, and excludes resyncs.

PMCx0C5 Retired Taken Branch Instructions Mispredicted

The number of retired taken branch instructions that were mispredicted, and excludes resyncs.

PMCx0C6 Retired Far Control Transfers

The number of far control transfers retired including far call/jump/return, IRET, SYSCALL and SYSRET, plus exceptions and interrupts, and excludes resyncs. Far control transfers are not subject to branch prediction.

PMCx0C7 Retired Branch Resyncs

The number of resync branches. These reflect pipeline restarts due to certain microcode assists and events such as writes to the active instruction stream, among other things. Each occurrence reflects a restart penalty similar to a branch mispredict. This is relatively rare.

PMCx0C8 Retired Near Returns

The number of near return instructions (RET or RET Iw) retired.

PMCx0C9 Retired Near Returns Mispredicted

A near return instruction was retired that mispredicted in either target or direction.

PMCx0CA Retired Mispredicted Taken Branch Instructions due to Target Mismatch

A taken branch instruction was retired that mispredicted in target address (but not in direction).

PMCx0CB Retired MMX/FP Instructions

A floating point (x87, MMX, or SSE) instruction was retired. The UnitMask allows the distinction between x87/MMX and SSE instructions. Since this event includes non-numeric instructions it is not suitable for measuring MFLOPS.

UnitMask	Description
7:2	Reserved.
1	SSE floating point instruction was retired (SSE, SSE2, SSE3, MNI)
0	x87 or MMX™ instruction was retired

PMCx0CD Interrupts-Masked Cycles

The number of processor cycles where interrupts are masked (EFLAGS.IF = 0). Using edge-counting with this event gives the number of times IF is cleared; dividing the cycle-count value by this value gives the average length of time that interrupts are disabled on each instance. Compare the edge count with [PMCx0CF](#) to determine how often interrupts are disabled for interrupt handling vs. other reasons (e.g. critical sections).

PMCx0CE Interrupts-Masked Cycles with Interrupt Pending

The number of processor cycles where interrupts are masked (EFLAGS.IF = 0) and an interrupt is pending.

Using edge-counting with this event and comparing the resulting count with the edge count for [PMCx0CD](#) gives the proportion of interrupts for which handling is delayed due to prior interrupts being serviced, critical sections, etc. The cycle count value gives the total amount of time for such delays. The cycle count divided by the edge count gives the average length of each such delay.

PMCx0CF Interrupts Taken

The number of hardware interrupts taken. This does not include software interrupts (INT n instruction).

PMCx0DB FPU Exceptions

The number of floating point unit exceptions for microcode assists. The UnitMask may be used to isolate specific types of exceptions.

UnitMask	Description
7:4	Reserved.
3	SSE and x87 microtraps
2	SSE reclass microfaults
1	SSE retype microfaults
0	x87 reclass microfaults

PMCx0D[F:C] DR[3:0] Breakpoint Matches

Table 254: [Register Mapping](#) for [PMCx0D\[F:C\]](#)

Register	Function
PMCx0DC	DR0
PMCx0DD	DR1
PMCx0DE	DR2
PMCx0DF	DR3

The number of matches on the address in breakpoint register DR0, per the breakpoint type specified in DR7. The breakpoint does not have to be enabled. Each instruction breakpoint match incurs an overhead of about 120 cycles; load/store breakpoint matches do not incur any overhead.

PMCx1CF Tagged IBS Ops

Number of ops tagged by IBS.

PMCx1D0 Tagged IBS Ops Retired

The number of retired tagged IBS operations.

3.24 L2I Performance Counter Events

L2IPMCx060 Command Related to Victim Buffers

UnitMask	Description
7	Lock.
6:5	Reserved.
4	ClVicBlk: clean victim command.
3	WrVicBlkNR: write victim block non-rinsing.
2	WrVicBlkR: write victim block rinsing.
1:0	Reserved.

L2IPMCx061 Command Related to Masked Operations

Count Masked Byte and DW reads and writes to the NB. Byte sized read and write commands can request the transfer of up to 32 bytes. DW sized read and write commands can request the transfer of up to 32 DW's. Combining of the WC memory type can cause 1 B/DW write to represent multiple stores.

UnitMask	Description
7:6	Reserved.
5	WrDWord: write double-word.
4	WrByte: write byte.
3	Reserved.
2	RdDWord: read double-word.
1	Reserved.
0	RdByte: read-byte.

L2IPMCx062 Command Related to Read Block Operations

UnitMask	Description
7:3	Reserved.
2	RdBlkS: read block shared.
1	RdBlkM: read block modified.
0	RdBlk: read block.

L2IPMCx063 Command Related to Change to Dirty Operations

UnitMask	Description
7:5	Reserved.
4	ChgToDirty: change to dirty.
3:0	Reserved.

L2IPMCx06C Response From System on Cache Refills

The number of responses from the system for cache refill requests. The UnitMask may be used to select specific cache coherency states. Each increment represents one 64 B cache line transferred from the system (DRAM or another cache, including another core on the same node) to the data cache, instruction cache or L2 cache (for data prefetcher and TLB table walks). Modified-state responses may be for Dcache store miss refills, PrefetchW software prefetches, hardware prefetches for a store-miss stream, or Change-to-Dirty requests that get a dirty (Owned) probe hit in another cache. Exclusive responses may be for any Icache refill, Dcache load miss refill, other software prefetches, hardware prefetches for a load-miss stream, or TLB table walks that miss in the L2 cache; Shared responses may be for any of those that hit a clean line in another cache.

UnitMask	Description
7	Reserved.
6	Uncacheable.
5	ChgToDirtySuccess.
4	DataError.
3	Owned.
2	Shared.
1	Modified.
0	Exclusive.

L2IPMCx07D Requests to L2 Cache

UnitMask	Description
7	Reserved.
6	PrefReq. L2 cache prefetcher request.
5:4	Reserved.
3	NbPrbReq. NB probe request.
2	Reserved.
1	DcFill. DC fill.
0	IcFill. IC fill.

L2IPMCx07E L2 Cache Misses

The number of requests that miss in the L2 cache. This may include some amount of speculative activity. The IC-fill-miss and DC-fill-miss events tend to mirror the Icache and Dcache refill-from-system [PMCx083](#) and [PMCx043](#), and tend to include more speculative activity than those events.

UnitMask	Description
7:5	Reserved.
4	L2PrefReq. L2 Cache Prefetcher request
3:2	Reserved.
1	DcFill.
0	IcFill.

L2IPMCx07F L2 Fill/Writeback

UnitMask	Description
7:3	Reserved.
2	L2CleanWritebacks. L2 Clean Writebacks to system.
1	L2Writebacks. L2 Writebacks to system (Clean and Dirty).
0	L2Fills. L2 fills from system. Note: Fills for non-temporal software prefetch and WP-memtype fills also are counted in this event even though they don't get cached in L2.

3.25 NB Performance Counter Events

This section provides the performance counter events that may be selected through [MSRC001_024\[6,4,2,0\]\[EventSelect,UnitMask\]](#). See that register and [MSRC001_024\[7,5,3,1\]](#) [Northbridge Performance Event Counter (NB_PERF_CTR[3:0])].

3.25.1 PMCx0E[7:4] Events (Memory Controller)**NBPMCx0E4 Memory Controller Bypass Counter Saturation**

UnitMask	Description																		
7:6	Reserved.																		
5	DCQ Bypass Saturated. The DCT is selected by the field NBPMCx0E4[4:2].																		
4:2	Select DCQ bypass: <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Select DCT0 DCQ bypass</td></tr> <tr> <td>001b</td><td>Select DCT1 DCQ bypass</td></tr> <tr> <td>010b</td><td>Select DCT2 DCQ bypass</td></tr> <tr> <td>011b</td><td>Select DCT3 DCQ bypass</td></tr> <tr> <td>100b</td><td>Select DCT4 DCQ bypass</td></tr> <tr> <td>101b</td><td>Select DCT5 DCQ bypass</td></tr> <tr> <td>110b</td><td>Select DCT6 DCQ bypass</td></tr> <tr> <td>111b</td><td>Select DCT7 DCQ bypass</td></tr> </table>	Bits	Description	000b	Select DCT0 DCQ bypass	001b	Select DCT1 DCQ bypass	010b	Select DCT2 DCQ bypass	011b	Select DCT3 DCQ bypass	100b	Select DCT4 DCQ bypass	101b	Select DCT5 DCQ bypass	110b	Select DCT6 DCQ bypass	111b	Select DCT7 DCQ bypass
Bits	Description																		
000b	Select DCT0 DCQ bypass																		
001b	Select DCT1 DCQ bypass																		
010b	Select DCT2 DCQ bypass																		
011b	Select DCT3 DCQ bypass																		
100b	Select DCT4 DCQ bypass																		
101b	Select DCT5 DCQ bypass																		
110b	Select DCT6 DCQ bypass																		
111b	Select DCT7 DCQ bypass																		
1	Memory controller medium priority bypass																		
0	Memory controller high priority bypass																		

3.25.2 PMCx0E[F:8] Events (Crossbar)**NBPMCx0E8 Thermal Status**

UnitMask	Description
7	Reserved
6	Number of clocks HTC P-state is active
5	Number of clocks HTC P-state is inactive

4	Reserved.
3	Reserved.
2	Number of times the HTC trip point is crossed
1:0	Reserved

NBPMCx0E9 CPU/IO Requests to Memory/IO

These events reflect request flow between units and nodes, as selected by the UnitMask. The UnitMask is divided into two fields: request type (CPU or IO access to IO or Memory) and source/target location (local vs. remote). One or more requests types must be enabled via bits 3:0, and at least one source and one target location must be selected via bits 7:4. Each event reflects a request of the selected type(s) going from the selected source(s) to the selected target(s).

Not all possible paths are supported. The following table shows the UnitMask values that are valid for each request type:

Source/Target	CPU to Mem	CPU to IO	IO to Mem	IO to IO
Local -> Local	A8h	A4h	A2h	A1h
Local -> Remote	98h	94h	92h	91h
Remote -> Local	-	64h	-	61h
Remote -> Remote	-	-	-	-

Any of the mask values shown may be logically ORed to combine the events. For instance, local CPU requests to both local and remote nodes would be $A8h \mid 98h = B8h$. Any CPU to any IO would be $A4h \mid 94h \mid 64h = F4h$ (but remote CPU to remote IO requests would not be included).

Note: It is not possible to tell from these events how much data is going in which direction, as there is no distinction between reads and writes. Also, particularly for IO, the requests may be for varying amounts of data, anywhere from one to sixty-four bytes. For a direct measure of the amount and direction of data flowing between nodes, use events F6h, F7h and F8h.

UnitMask	Description
7	From local node
6	From remote node
5	To local node
4	To remote node
3	CPU to Mem
2	CPU to IO
1	IO to Mem
0	IO to IO

NBPMCx0EA Cache Block Commands

The number of requests made to the system for cache line transfers or coherency state changes, by request type. Each increment represents one cache line transfer, except for Change-to-Dirty. If a Change-to-Dirty request

hits on a line in another processor's cache that's in the Owned state, it causes a cache line transfer, otherwise there is no data transfer associated with Change-to-Dirty requests.

UnitMask	Description
7:6	Reserved.
5	Change-to-Dirty (first store to clean block already in cache)
4	Read Block Modified (Dcache store miss refill)
3	Read Block Shared (Icache refill)
2	Read Block (Dcache load miss refill)
1	Reserved.
0	Victim Block (Writeback)

NBPMCx0EB Sized Commands

The number of Sized Read/Write commands handled by the System Request Interface (local processor and hostbridge interface to the system). These commands may originate from the processor or hostbridge. Typical uses of the various Sized Read/Write commands are given in the UnitMask table. See [NBPMCx0EC](#), which provides a separate measure of Hostbridge accesses.

UnitMask	Description
7:6	Reserved.
5	SzRd DW (1-16 DWORDs). Typical Usage: Block-oriented DMA reads, typically cache-line size.
4	SzRd Byte (4 bytes). Typical Usage: Legacy or mapped IO.
3	Posted SzWr DW (1-16 DWORDs). Typical Usage: Block-oriented DMA writes, often cache-line sized; also processor Write Combining buffer flushes.
2	Posted SzWr Byte (1-32 bytes). Typical Usage: Sub-cache-line DMA writes, size varies; also flushes of partially-filled Write Combining buffer.
1	Non-Posted SzWr DW (1-16 DWORDs). Typical Usage: Legacy or mapped IO, typically 1 DWORD.
0	Non-Posted SzWr Byte (1-32 bytes). Typical Usage: Legacy or mapped IO, typically 1-4 bytes.

NBPMCx0EC Probe Responses and Upstream Requests

This covers two unrelated sets of events: cache probe results, and requests received by the hostbridge from devices on non-coherent links.

Probe results: These events reflect the results of probes sent from a memory controller to local caches. They provide an indication of the degree data and code is shared between processors (or moved between processors due to process migration). The dirty-hit events indicate the transfer of a 64-byte cache line to the requestor (for a read or cache refill) or the target memory (for a write). The system bandwidth used by these, in terms of bytes per unit of time, may be calculated as 64 times the event count, divided by the elapsed time. Sized writes to memory that cover a full cache line do not incur this cache line transfer -- they simply invalidate the line and are reported as clean hits. Cache line transfers occur for Change2Dirty requests that hit cache lines in the Owned state. (Such cache lines are counted as Modified-state refills for [PMCx06C](#), System Read Responses.)

Upstream requests: The upstream read and write events reflect requests originating from a device on a local IO link.

UnitMask	Description
7	Upstream non-ISOC writes
6	Upstream ISOC writes
5	Upstream non-display refresh reads
4	Upstream display refresh/ISOC reads
3	Probe hit dirty with memory cancel (probed by DMA read or cache refill request)
2	Probe hit dirty without memory cancel (probed by Sized Write or Change2Dirty)
1	Probe hit clean
0	Probe miss

3.25.3 PMCx0F[F:0] Events (Crossbar)

3.25.4 NBPMCx1E[F:0] Events (Crossbar)

NBPMCx1E0 CPU to DRAM Requests to Target Node

This event counts all DRAM reads and writes generated by cores on the local node to the targeted node in the coherent fabric. This counter can be used to observe processor data affinity in NUMA aware operating systems.

UnitMask	Description
7	From Local node to Node 7
6	From Local node to Node 6
5	From Local node to Node 5
4	From Local node to Node 4
3	From Local node to Node 3
2	From Local node to Node 2
1	From Local node to Node 1
0	From Local node to Node 0

NBPMCx1E1 IO to DRAM Requests to Target Node

This event counts all DRAM reads and writes generated by IO devices attached to the IO links of the local node the targeted node in the coherent fabric. This counter can be used to observe IO device data affinity in NUMA aware operating systems.

UnitMask	Description
7	From Local node to Node 7
6	From Local node to Node 6
5	From Local node to Node 5
4	From Local node to Node 4
3	From Local node to Node 3
2	From Local node to Node 2

1	From Local node to Node 1
0	From Local node to Node 0

NBPMCx1E2 CPU Read Command Latency to Target Node 0-3

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E3](#) to determine the average latency for the command type.

UnitMask	Description
7	From Local node to Node 3
6	From Local node to Node 2
5	From Local node to Node 1
4	From Local node to Node 0
3	Change-to-Dirty
2	Read block modified
1	Read block shared
0	Read block

NBPMCx1E3 CPU Read Command Requests to Target Node 0-3

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E2](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type.

UnitMask	Description
7	From Local node to Node 3
6	From Local node to Node 2
5	From Local node to Node 1
4	From Local node to Node 0
3	Change-to-Dirty
2	Read block modified
1	Read block shared
0	Read block

NBPMCx1E4 CPU Read Command Latency to Target Node 4-7

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E5](#) to determine the average latency for the command type.

UnitMask	Description
7	From Local node to Node 7
6	From Local node to Node 6
5	From Local node to Node 5
4	From Local node to Node 4
3	Change-to-Dirty
2	Read block modified
1	Read block shared
0	Read block

NBPMCx1E5 CPU Read Command Requests to Target Node 4-7

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E4](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type.

UnitMask	Description
7	From Local node to Node 7
6	From Local node to Node 6
5	From Local node to Node 5
4	From Local node to Node 4
3	Change-to-Dirty
2	Read block modified
1	Read block shared
0	Read block

NBPMCx1E6 CPU Command Latency to Target Node 0-3/4-7

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node, UnitMask[3] to select the node group and UnitMask[3:0] to select the command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E7](#) to determine the average latency for the command type.

UnitMask	Description
7	From Local node to Node 3/7
6	From Local node to Node 2/6
5	From Local node to Node 1/5
4	From Local node to Node 0/4
3	Node Group Select. 0=Nodes 0-3. 1= Nodes 4-7.
2	Victim Block
1	Write Sized
0	Read Sized

NBPMCx1E7 CPU Requests to Target Node 0-3/4-7

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E6](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node, UnitMask[3] to select the node group and UnitMask[3:0] to select the command type.

UnitMask	Description
7	From Local node to Node 3/7
6	From Local node to Node 2/6
5	From Local node to Node 1/5
4	From Local node to Node 0/4
3	Node Group Select. 0=Nodes 0-3. 1= Nodes 4-7.
2	Victim Block
1	Write Sized
0	Read Sized

NBPMCx1EB Request Cache Status 1

The probe response type for RdBlkM or ChgToDirty request type.

UnitMask	Description
7	Track Cache Stat for RdBlkM
6	Track Cache Stat for ChgToDirty
5	Directed Probe
4	Probe Miss
3	Probe Hit M
2	Probe Hit MuW or O
1	Probe Hit E
0	Probe Hit S

3.25.5 NBPMCx1F[F:0] Events (Memory Controller, Crossbar)

NBPMCx1F0 Memory Controller Requests

Read/Write requests: The read/write request events reflect the total number of commands sent to the DRAM controller.

Sized Read/Write activity: The Sized Read/Write events reflect 32- or 64-byte transfers (as opposed to other sizes which could be anywhere between 1 and 64 bytes), from either the processor or the Hostbridge (on any node in an MP system). Such accesses from the processor would be due only to write combining buffer flushes, where 32-byte accesses would reflect flushes of partially-filled buffers. [PMCx065](#) provides a count of sized write requests associated with WC buffer flushes; comparing that with counts for these events (providing there is very little Hostbridge activity at the same time) gives an indication of how efficiently the write combining buffers are being used. [PMCx065](#) may also be useful in factoring out WC flushes when comparing these events with the Upstream Requests component of [PMCx06C](#).

UnitMask	Description
7	Read requests sent to the DCT while writes requests are pending in the DCT
6	64 Byte Sized Reads
5	32 Bytes Sized Reads
4	64 Bytes Sized Writes
3	32 Bytes Sized Writes
2	Prefetch requests sent to the DCT
1	Read requests (including prefetch requests) sent to the DCT
0	Write requests sent to the DCT

NBPMCx3EC DRAM Accesses

The number of memory accesses performed by the local DRAM controller. UnitMask[7:0] may be used to isolate the different DRAM page access cases. Page miss cases incur an extra latency to open a page; page conflict cases incur both a page-close as well as page-open penalties. These penalties may be overlapped by DRAM accesses for other requests and don't necessarily represent lost DRAM bandwidth. The associated penalties are as follows:

Page miss: Trcd (DRAM RAS-to-CAS delay)

Page conflict: Trp + Trcd (DRAM row-precharge time plus RAS-to-CAS delay)

Each DRAM access represents one 64-byte block of data transferred if the DRAM is configured for 64-byte granularity, or one 32-byte block if the DRAM is configured for 32-byte granularity. (The latter is only applicable to single-channel DRAM systems, which may be configured either way.)

UnitMask	Description
7:6	Reserved.
5	DCT1 Page Conflict
4	DCT1 Page Miss
3	DCT1 Page hit
2	DCT0 Page Conflict
1	DCT0 Page Miss
0	DCT0 Page hit

NBPMCx3ED DRAM Controller Page Table Overflows

The number of page table overflows in the local DRAM controller. This table maintains information about which DRAM pages are open. An overflow occurs when a request for a new page arrives when the maximum number of pages are already open. Each occurrence reflects an access latency penalty equivalent to a page conflict.

UnitMask	Description
7:2	Reserved.

1	DCT1 Page Table Overflow
0	DCT0 Page Table Overflow

NBPMCx3EE Memory Controller DRAM Command Slots Missed

UnitMask	Description
7:2	Reserved.
1	DCT1 Command Slots Missed (in MEMCLKs)
0	DCT0 Command Slots Missed (in MEMCLKs)

NBPMCx3EF Memory Controller Turnarounds

The number of turnarounds on the local DRAM data bus. UnitMask[7:0] may be used to isolate the different cases. These represent lost DRAM bandwidth, which may be calculated as follows (in bytes per occurrence):

DIMM turnaround: $\text{DRAM_width_in_bytes} * 2 \text{ edges_per_memclk} * 2$
R/W turnaround: $\text{DRAM_width_in_bytes} * 2 \text{ edges_per_memclk} * 1$
R/W turnaround: $\text{DRAM_width_in_bytes} * 2 \text{ edges_per_memclk} * (\text{Tcl}-1)$

where DRAM_width_in_bytes is 8 or 16 (for single- or dual-channel systems), and Tcl is the CAS latency of the DRAM in memory system clock cycles (where the memory clock for DDR-400, or PC3200 DIMMS, for example, would be 200 MHz).

UnitMask	Description
7:6	Reserved.
5	DCT1 Write to read turnaround
4	DCT1 Read to write turnaround
3	DCT1 DIMM (chip select) turnaround
2	DCT0 Write to read turnaround
1	DCT0 Read to write turnaround
0	DCT0 DIMM (chip select) turnaround

3.26 Fusion Controller Hub Registers

3.26.1 Legacy Block Configuration Registers (IO)

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention.

IO000 Dma_Ch 0

Bits	Description
15:0	DmaCh0 . Read-write. Reset: 0. DMA1 channel 0 base and current address.

IO002 Dma_Ch 1

Bits	Description
15:0	DmaCh1 . Read-write. Reset: 0. DMA1 channel 1 base and current address.

IO004 Dma_Ch 2

Bits	Description
15:0	DmaCh2 . Read-write. Reset: 0. DMA1 channel 2 base and current address.

IO006 Dma_Ch 3

Bits	Description
15:0	DmaCh3 . Read-write. Reset: 0. DMA1 channel 3 base and current address.

IO008 Dma_Status

Bits	Description
7:0	DmaStatus . Read-write. Reset: 0. Specifies the DMA status register for channels 0-3 for reads; specifies the DMA control register for channels 0-3 for writes.

IO009 Dma_WriteRequest

Bits	Description
7:0	DmaWriteRequest . Read-write. Reset: 0. Request register.

IO00A Dma_WriteMask

Bits	Description
7:0	DmaWriteMask . Read-write. Reset: 0. DMA channel mask register.

IO00B Dma_WriteMode

Bits	Description
7:0	DmaWriteMode . Read-write. Reset: 0. DMA mode register.

IO00C Dma_Clear

Bits	Description
7:0	DmaClear . Read-write. Reset: 0. Channel 0-3 DMA clear byte pointer.

IO00D Dma_MasterClr

Dma_MasterClr register

Bits	Description
7:0	DmaMasterClr . Read-write. Reset: 0. Write: Channel 0-3 master clear register. Read: Intermediate register.

IO00E Dma_ClrMask

Bits	Description
7:0	DmaClrmask . Read-write. Reset: 0. Channel 0-3 DMA clear mask.

IO00F Dma_AllMask

Bits	Description
7:0	DmaAllMask . Read-write. Reset: 0. General mask register.

IO020 IntrCntnl1Reg1

Bits	Description
7:0	IntrCntnl1Reg1 . Read-write. Reset: 0. IRQ0-7 status and control. Read: IRR, ISR. Write: ICW1, OCW2, OCW3.

IO021 IntrCntnl1Reg2

Bits	Description
7:0	IntrCntnl1Reg2 . Read-write. Reset: 0. IRQ0-7 status and control. Read: IMR. Write: ICW2, ICW3, ICW4, OCW1.

IO022 IMCR_Index

Bits	Description
7:0	ImcrIndex . Read-write. Reset: 0. Index port for IMCR register. See IO023 [IMCR_Data] .

IO023 IMCR_Data

Bits	Description
7:0	ImcrData . Read-write. Reset: 0. Data port for IMCR register. The actual IMCR register is located at index 70h and it is at bit 0.

IO040 TimerCh0

Bits	Description
7:0	TimerCh0 . Read-write. Reset: 0. 8254 Timer 1 Counter 0 Data Port.

IO041 TimerCh1

Bits	Description
7:0	TimerCh1 . Read-write. Reset: 0. 8254 Timer 1 Counter 1 Data Port.

IO042 TimerCh2

Bits	Description
7:0	TimerCh2 . Read-write. Reset: 0. 8254 Timer 1 Counter 2 Data Port.

IO043 Tmr1CntrlWord

Bits	Description										
7:6	CounterSelect . Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Select counter 0</td></tr> <tr> <td>01b</td><td>Select counter 1</td></tr> <tr> <td>10b</td><td>Select counter 2</td></tr> <tr> <td>11b</td><td>Read back command</td></tr> </table>	Bits	Definition	00b	Select counter 0	01b	Select counter 1	10b	Select counter 2	11b	Read back command
Bits	Definition										
00b	Select counter 0										
01b	Select counter 1										
10b	Select counter 2										
11b	Read back command										
5:4	CommandSelect . Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Counter latch command</td></tr> <tr> <td>01b</td><td>Read/write least significant byte</td></tr> <tr> <td>10b</td><td>Read/write most significant byte</td></tr> <tr> <td>11b</td><td>Read/write least, and then most significant byte</td></tr> </table>	Bits	Definition	00b	Counter latch command	01b	Read/write least significant byte	10b	Read/write most significant byte	11b	Read/write least, and then most significant byte
Bits	Definition										
00b	Counter latch command										
01b	Read/write least significant byte										
10b	Read/write most significant byte										
11b	Read/write least, and then most significant byte										

3:1	ModeSelect. Read-write. Reset: 0.																
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Asserts OUT signal at end of count</td></tr> <tr> <td>001b</td><td>Hardware re-triggerable one-shot</td></tr> <tr> <td>010b</td><td>Rate generator</td></tr> <tr> <td>011b</td><td>Square wave output</td></tr> <tr> <td>100b</td><td>Software triggered strobe</td></tr> <tr> <td>101b</td><td>Hardware triggered strobe</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	Bits	Definition	000b	Asserts OUT signal at end of count	001b	Hardware re-triggerable one-shot	010b	Rate generator	011b	Square wave output	100b	Software triggered strobe	101b	Hardware triggered strobe	111b-110b	Reserved
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111b-110b	Reserved																
0	CntDownSelect. Read-write. Reset: 0. 0=Binary countdown. 1=BCD countdown.																

IO060 Keyboard Data

Bits	Description
7:0	Data. Read-write. Reset: 0. Specifies the keyboard controller data port. It should only be read from when IO064[0] reads back 1. It should only be written to when IO064[1] reads back 0.

IO061 Nmi Status

Bits	Description
7	ParityErrNmi. Read-only. Reset: X. NMI is caused by parity error (either PERR# or SERR#).
6	IoChkNmi. Read-only. Reset: X. NMI is triggered by serial IOCHK.
5	SpkrClk. Read-only. Reset: X. The output of 8254 timer counter 2.
4	RefClk. Read-only. Reset: X. The output of 8254 timer counter 1.
3	IoChkNmiEn. Read-write. Reset: 1. 0=Enable IoChk to NMI generation. 1=Disable IoChk to NMI generation.
2	ParityErrNmiEn. Read-write. Reset: 1. 0=Enable Parity Error to NMI generation (from SERR# or PERR#). 1=Disable Parity Error to NMI generation and clear bit 7.
1	SpkrTmrEnable. Read-write. Reset: 0. 0=Speaker timer off. 1=Speaker timer on.
0	SpkrEnable. Read-write. Reset: 0. 0=Disable counter 2. 1=Enable counter 2.

IO064 Keyboard Command Status

This register reads the keyboard status on CPU reads and writes specify the keyboard command.

Bits	Description
7	KeyPar. Read-write; updated-by-hardware. Reset: 0. 1=Keyboard data transmission parity error.
6	KeyRTO. Read-write; updated-by-hardware. Reset: 0. 1= Receive time out.
5	KeyTTO. Read-write; updated-by-hardware. Reset: 0. 1=Keyboard transmit time out or mouse data available.
4	KeyEnB. Read-write; updated-by-hardware. Reset: 0. 0=Password protected.
3	CmdData. Read-write; updated-by-hardware. Reset: 0. 1=Between the keyboard command and data ports, the command port at 64h was last written to. 0=Between the keyboard command and data ports, the data port at 60h was last written to.

2	KeySys. Read-write; updated-by-hardware. Reset: 0. Specifies system flag status. 1=Power up or reset. 0=Soft reset.
1	KeyIBF. Read-write; updated-by-hardware. Reset: 0. 1=Input buffer full. 0=Ready to receive next command/data.
0	KeyOBF. Read-write; updated-by-hardware. Reset: 0. 1=Data is available to read back. 0=No data available.

IO070 RtcAddrPort and NmiMask

Bits	Description
7	NmiMask. Write-only. Reset: 0. 0=NMI enabled. 1=NMI masked.
6:0	RtcAddrPort: RTC Address Port. Read-write. Reset: 0. This is used with either internal RTC or external RTC. This port specifies the index to access RTC time registers and the CMOS RAM space. IO073_x0A[DV0] should be programmed first to select bank when accessing the CMOS RAM space. See IO073_x00 .

IO071 RtcDataPort

Bits	Description
7:0	RtcDataPort: RTC Data Port. Read-write. Reset: 0. This is used with either internal RTC or external RTC in conjunction with IO070 .

IO072 Alternate RTC AddrPort

Bits	Description
7:0	AlternatRTCAddrPort. Read-write. Reset: 0. This is used with internal RTC. This port allows user to specify the full 8 bit address (instead of bank0/bank1 indexing) to access the 256 bytes of RTC RAM.

IO073 Alternate RTC DataPort

Bits	Description
7:0	AlternatRTCDataPort. Read-write. Reset: 0. This is used with internal RTC in conjunction with IO072 .

IO073_x00 RTC Seconds

Bits	Description
7:0	Seconds. Read-write. Reset: 0. BCD format. The value range for this register is 00 through 59. If (IO073_x0B[SET] =1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B[SET] =0), this register is updated by the RTC logic once per second.

IO073_x01 RTC Seconds Alarm

Bits	Description
7:0	SecondsAlarm: Seconds Alarm. Read-write. Reset: 0. BCD format. If (IO073_x0B[SET]=1), the Seconds Alarm register will never match with IO073_x00 [RTC Seconds]. Else, if (bits [7:6] = 11b) the RTC Seconds Alarm register always matches with RTC Seconds register and causes an RTC alarm event to be generated once per second. See IO073_x0C[AF].

IO073_x02 RTC Minutes

Bits	Description
7:0	Minutes. Read-write. Reset: 0. BCD format. The value range for this register is 00 through 59. If (IO073_x0B[SET]=1), this register programmed by software and hardware updating is disabled. If (IO073_x0B[SET]=0), this register is updated by the RTC logic once per second.

IO073_x03 RTC Minutes Alarm

Bits	Description
7:0	MinutesAlarm: Minutes Alarm. Read-write. Reset: 0. BCD format. If (IO073_x0B[SET]=1), the RTC Minutes Alarm register will never match with IO073_x02 [RTC Minutes]. Else, if (bits [7:6]=11b), the RTC Minutes Alarm register always matches with RTC Minutes register and causes an RTC alarm event to be generated once per minute. See IO073_x0C[AF].

IO073_x04 RTC Hours

Bits	Description
7:0	Hours. Read-write. Reset: 0. BCD format. The value range for this register is 00 through 23. If (IO073_x0B[SET]=1), this register can be set by software and hardware updating is disabled. If (IO073_x0B[SET]=0), this register is updated by the RTC logic once per second.

IO073_x05 RTC Hours Alarm

Bits	Description
7:0	HoursAlarm: Hours Alarm. Read-write. Reset: 0. BCD format. If (IO073_x0B[SET]=1), the RTC Hours Alarm register will never match with IO073_x04 [RTC Hours]. Else, if (bits [7:6] = 11b) the RTC Hours Alarm register always matches with the RTC Hours register and causes an RTC alarm event to be generated once per hour. See IO073_x0C[AF].

IO073_x06 RTC Day of Week

Bits	Description
7:0	DayOfWeek: Day of Week. Read-write. Reset: 0. BCD format. The value range for this register is 01 through 07 (Sunday = 1). Leap year correction is performed by software. If (IO073_x0B[SET]==1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B[SET]==0), this register is updated by hardware.

IO073_x07 RTC Date of Month

Bits	Description
7:0	DateOfMonth: Date of Month. Read-write. Reset: 0. BCD format. The range is 01 through 31. Leap year correction is performed by software. If (IO073_x0B[SET]==1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B[SET]==0), this register is updated by hardware.

IO073_x08 RTC Month

Bits	Description
7:0	Month. Read-write. Reset: 0. BCD format. The range is 01 through 12. Leap year correction is performed by software. If (IO073_x0B[SET]=1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B[SET]=0), this register is updated by hardware.

IO073_x09 RTC Year

Bits	Description
7:0	Year. Read-write. Reset: 0. BCD format. Range is 00 through 99. No leap year correction capability. Leap year correction has to be done by software. If (IO073_x0B[SET]=1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B[SET]=0), this register is updated by hardware.

IO073_x0A RTC Register A

Bits	Description
7	UIP: Update In Progress. Read-only. Reset: 0. If (IO073_x0B[SET]=1), UIP is cleared. 1=The update transfer will soon occur. 0=The update transfer will not occur for at least 244 us.
6:5	Reserved.

4	DV0: Bank Selection. Read-write. Reset: 0. 0=Select bank 0 when accessing the RTC CMOS RAM space through IO070 and IO071 . 1=Select bank 1 when accessing the RTC CMOS RAM space through IO070 and IO071 . The FCH has an alternate way to access the RAM without the use of bank select bit. IO072 [Alternate RTC AddrPort] and IO073 [Alternate RTC DataPort] provides indexed access to the full 256 bytes of RAM.																																		
3:0	<p>RS[3:0]: Rate Selection. Read-write. Reset: 0. These four rate selection bits select one of the 13 taps on the 15-stage frequency divider or disable the divider output (flat output signal). The tap selected can be used to generate a periodic interrupt. See the following table for the frequency selection.</p> <table> <tr> <th>Bits</th><th>Tap Frequency (Interrupt Rate)</th></tr> <tr><td>0000b</td><td>Flat Signal (None)</td></tr> <tr><td>0001b</td><td>256 Hz (3.90625 ms)</td></tr> <tr><td>0010b</td><td>128 Hz (7.8125 ms)</td></tr> <tr><td>0011b</td><td>8.192 kHz (122.070 us)</td></tr> <tr><td>0100b</td><td>4.096 kHz (244.141 us)</td></tr> <tr><td>0101b</td><td>2.048 kHz (488.281 us)</td></tr> <tr><td>0110b</td><td>1.024 kHz (976.5625 us)</td></tr> <tr><td>0111b</td><td>512 Hz (1.953125 ms)</td></tr> <tr><td>1000b</td><td>256 Hz (3.90625 ms)</td></tr> <tr><td>1001b</td><td>128 Hz (7.8125 ms)</td></tr> <tr><td>1010b</td><td>64 Hz (15.625 ms)</td></tr> <tr><td>1011b</td><td>32 Hz (31.25 ms)</td></tr> <tr><td>1100b</td><td>16 Hz (62.5 ms)</td></tr> <tr><td>1101b</td><td>8 Hz (125 ms)</td></tr> <tr><td>1110b</td><td>4 Hz (250 ms)</td></tr> <tr><td>1111b</td><td>2 Hz (500 ms)</td></tr> </table>	Bits	Tap Frequency (Interrupt Rate)	0000b	Flat Signal (None)	0001b	256 Hz (3.90625 ms)	0010b	128 Hz (7.8125 ms)	0011b	8.192 kHz (122.070 us)	0100b	4.096 kHz (244.141 us)	0101b	2.048 kHz (488.281 us)	0110b	1.024 kHz (976.5625 us)	0111b	512 Hz (1.953125 ms)	1000b	256 Hz (3.90625 ms)	1001b	128 Hz (7.8125 ms)	1010b	64 Hz (15.625 ms)	1011b	32 Hz (31.25 ms)	1100b	16 Hz (62.5 ms)	1101b	8 Hz (125 ms)	1110b	4 Hz (250 ms)	1111b	2 Hz (500 ms)
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IO073_x0B RTC Register B

Bits	Description
7	SET: Set new time. Read-write. Reset: 0. 1=No internal updating for RTC time registers occurs. 0=The RTC time registers are updated every second.
6	PIE: Periodic Interrupt Enable. Read-write. Reset: 0. 1=Enable the IO073_x0C[PF] bit to assert IRQ.
5	AIE: Alarm Interrupt Enable. Read-write. Reset: 0. 1=Enable the IO073_x0C[AF] bit to assert IRQ. When the alarm time is written in the appropriate hours, minutes, and seconds alarm registers, the alarm interrupt is initiated at the specified time each day if AIE=1.
4	UIE: Update Ended Interrupt Enable. Read-write. Reset: 0. 1=Enable the IO073_x0C[UF] bit to assert IRQ. If [SET]=1, UIE is cleared.
3:2	Reserved.
1	HourMode. Read-write. Reset: 0. 0=12 hour mode. 1=24 hour mode.
0	DaylightSavingEnable. Read-write. Reset: X. BIOS: 0. 1=If (PMx5F_x00[DltSavEnable] ==1) RTC daylight saving is enabled.

IO073_x0C RTC Register C

Bits	Description
7	IRQF: Interrupt Request Flag. Read-only. Reset: 0. $IRQF = (PF * PIE) + (AF * AIE) + (UF * UIE)$. 1=The IRQ# pin is driven low. Reading RTC Register C clears IRQF bit.
6	PF: Periodic Interrupt Flag. Read-only. Reset: 0. 1=An edge is detected on the selected tap (through RS3 to RS0) of the frequency divider. Reading RTC Register C clears PF bit.
5	AF: Alarm Interrupt Flag. Read-only. Reset: 0. 1= IO073_x00 [RTC Seconds] , IO073_x02 [RTC Minutes] , IO073_x04 [RTC Hours] and IO073_x07 [RTC Date of Month] match IO073_x01 [RTC Seconds Alarm] , IO073_x03 [RTC Minutes Alarm] , IO073_x05 [RTC Hours Alarm] , and IO073_x0D [RTC Date Alarm] respectively. Reading RTC Register C clears AF bit.
4	UF: Update Ended Interrupt Flag. Read-only. Reset: 0. 1=Update cycle complete. Reading RTC Register C clears UF.
3:0	Reserved.

IO073_x0D RTC Date Alarm

Bits	Description
7	VRT: Valid RAM and Time. Read-only. Reset: 1. 1=RTC date, time, and CMOS RAM are valid. 0=RTC date, time, and CMOS RAM are invalid due to low RTC battery being monitored. See PMx58 [VRT_T1] and PMx59 [VRT_T2] .
6	ScratchBit. Read-write. Reset: 0.
5:0	DateAlarm. Read-write. Reset: 0. If (DateAlarm!=0), then DateAlarm is considered for alarm generation. 0=DateAlarm is not compared for alarm generation. DateAlarm is in BCD format.

IO073_x32 RTC AltCentury

Bits	Description
7:0	AltCentury. Read-write. Reset: 0. BCD format. Leap year correction is performed by hardware. This register is accessed only when (IO073_x0A [DV0] =0) and (PMx56 [CenturyEn] =1). If (IO073_x0B [SET] =1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B [SET] =1), this register is automatically updated by hardware every century.

IO073_x48 RTC Century

Bits	Description
7:0	Century. Read-write. Reset: 0. BCD format. Leap year correction is done through hardware. This register is accessed only when (IO073_x0A [DV0] =1). If (IO073_x0B [SET] =1), this register is programmed by software and hardware updating is disabled. If (IO073_x0B [SET] =0), this register is automatically updated by hardware every century.

IO073_x50 RTC Extended RAM Address Port

Bits	Description
7	Reserved.
6:0	ExtendedRamAddrPort . Read-write. Reset: 0. Because only 7 address bits are used in IO070[RtcAddrPort] , only the lower 128 bytes at offset 7Fh:00h are accessible through IO071 [Rtc-DataPort] . The Extended RAM are physically located at address 80h to FFh. In order to access these addresses, an address offset should be programmed into this register and access to them is done through IO073_x53 [RTC Extended RAM Data Port] . An offset of 80h is automatically be added to this 7-bit address.

IO073_x53 RTC Extended RAM Data Port

Bits	Description
7:0	ExtendedRamDataPort . Read-write. Reset: X.

IO073_x7E RTC Time Clear

Bits	Description
7:1	Reserved.
0	RtcTimeClear . Read-write. Reset: 0. 1=Clear the RTC second and stop RTC time.

IO073_x7F RTC RAM Enable

Bits	Description
7:1	Reserved.
0	RtcRamEnable . Read-write. Reset: 1. 1=Enable access to the RTC RAM.

IO080 PostCode 0

Bits	Description
7:0	PostCode[7:0]: BIOS post code . Read-write. Reset: 0. BIOS post code register, can be 32-bits for writes, 8 bits for reads. See MISCx78 [PostCode] .

IF (![MISCx6C\[PostCodeWidthSel\]](#) && [D14F3x48\[IOPortEnable4\]](#)) THEN

IO081 PostCode 1

Bits	Description
7:0	PostCode[15:8]: BIOS post code . Read-write. Reset: 0.

ELSE

IO081 Dma_PageCh2

Bits	Description
7:0	DmaPagech2 . Read-write. Reset: 0. DMA2 channel 2 page register.

ENDIF

IF (!MISCx6C[PostCodeWidthSel] && D14F3x48[IOPortEnable4]) THEN

IO082 PostCode 2

Bits	Description
7:0	PostCode[23:16]: BIOS post code . Read-write. Reset: 0.

ELSE

IO082 Dma_PageCh3

Bits	Description
7:0	DmaPageCh3 . Read-write. Reset: 0. DMA2 channel 3 page register.

IF (!MISCx6C[PostCodeWidthSel] && D14F3x48[IOPortEnable4]) THEN

IO083 PostCode 3

Bits	Description
7:0	PostCode[31:24]: BIOS post code . Read-write. Reset: 0.

ELSE

IO083 Dma_PageCh1

Bits	Description
7:0	DmaPageCh1 . Read-write. Reset: 0. DMA2 channel 1 page register.

ENDIF

IO084 Dma_Page_Reserved1

Bits	Description
7:0	DmaPageReserved1 . Read-write. Reset: 0. DMA Page Reserved1 register.

IO085 Dma_Page_Reserved2

Bits	Description
7:0	DmaPageReserved2 . Read-write. Reset: 0. DMA Page Reserved2 register.

IO086 Dma_Page_Reserved3

Bits	Description
7:0	DmaPageReserved3 . Read-write. Reset: 0. DMA Page Reserved3 register.

IO087 Dma_PageCh0

Bits	Description
7:0	DmaPageCh0 . Read-write. Reset: 0. DMA2 channel 0 page register.

IO088 Dma_Page_Reserved4

Bits	Description
7:0	DmaPageReserved4 . Read-write. Reset: 0. DMA Page Reserved4 register.

IO089 Dma_PageCh6

Bits	Description
7:0	DmaPageCh6 . Read-write. Reset: 0. DMA2 channel 6 page register.

IO08A Dma_PageCh7

Bits	Description
7:0	DmaPageCh7 . Read-write. Reset: 0. DMA2 channel 7 page register.

IO08B Dma_PageCh5

Bits	Description
7:0	DmaPageCh5 . Read-write. Reset: 0. DMA2 channel 5 page register.

IO08C Dma_Page_Reserved5

Bits	Description
7:0	DmaPageReserved5 . Read-write. Reset: 0. DMA Page Reserved5 register.

IO08D Dma_Page_Reserved6

Bits	Description
7:0	DmaPageReserved6 . Read-write. Reset: 0. DMA Page Reserved6 register.

IO08E Dma_Page_Reserved7

Bits	Description
7:0	DmaPageReserved7 . Read-write. Reset: 0. DMA Page Reserved7 register.

IO08F Dma_Refresh

Bits	Description
7:0	DmaRefresh . Read-write. Reset: 0. DMA2 channel 4 page register.

IO092 FastInit

Bits	Description
7:2	Reserved.
1	A20EnB: A20 Enable Bar bit . Read-write. Reset: 0. 1=A20M# function is disabled.
0	FastInit . Read-write. Reset: 0. This bit provides a fast software executed processor reset function. 1=Generate INIT assertion for approximately 4 ms. 0=Before another INIT pulse can be generated via this register, this bit must be written back to a 0.

IO0A0 IntrCntrl2Reg1

Bits	Description
7:0	IntrCntrl2Reg1 . Read-write. Reset: 0. IRQ8-15 status and control. Read: IRR, ISR. Write: ICW1, OCW2, OCW3.

IO0A1 IntrCntrl2Reg2

Bits	Description
7:0	IntrCntrl2Reg2 . Read-write. Reset: 0. IRQ8-15 status and control. Read: IMR. Write: ICW2, ICW3, ICW4, OCW1.

IO0C0 Dma2_Ch4Addr

Bits	Description
7:0	Dma2Ch4Addr . Read-write. Reset: 0. DMA2 channel 4 base and current address.

IO0C2 Dma2_Ch4Cnt

Bits	Description
7:0	Dma2Ch4Cnt . Read-write. Reset: 0. DMA2 channel 4 base and current count.

IO0C4 Dma2_Ch5Addr

Bits	Description
7:0	Dma2Ch5Addr. Read-write. Reset: 0. DMA2 channel 5 base and current address.

IO0C6 Dma2_Ch5Cnt

Bits	Description
7:0	Dma2Ch5Cnt. Read-write. Reset: 0. DMA2 channel 5 base and current count.

IO0C8 Dma2_Ch6Addr

Bits	Description
7:0	Dma2Ch6Addr. Read-write. Reset: 0. DMA2 channel 6 base and current address.

IO0CA Dma2_Ch6Cnt

Bits	Description
7:0	Dma2Ch6Cnt. Read-write. Reset: 0. DMA2 channel 6 base and current count.

IO0CC Dma2_Ch7Addr

Bits	Description
7:0	Dma2Ch7Addr. Read-write. Reset: 0. DMA2 channel 7 base and current address.

IO0CE Dma_Ch7Cnt

Bits	Description
7:0	Dma2Ch7Cnt. Read-write. Reset: 0. DMA2 channel 7 base and current count.

IO0D0 Dma_Status

Bits	Description
7:0	DmaStatus. Read-write. Reset: 0. DMA2 status register.

IO0D2 Dma_WriteRequest

Bits	Description
7:0	DmaWriteRequest. Read-write. Reset: 0. DMA2 request register.

IO0D4 Dma_WriteMask

Bits	Description
7:0	DmaWriteMask . Read-write. Reset: 0. DMA2 channel mask register.

IO0D6 Dma_WriteMode

Bits	Description
7:0	DmaWriteMode . Read-write. Reset: 0. DMA2 mode register.

IO0D8 Dma_Clear

Bits	Description
7:0	DmaClear . Read-write. Reset: 0. Channel 4-7 clear byte pointer.

IO0DA Dma_MasterClr

Bits	Description
7:0	DmaMasterClear . Read-write. Reset: 0. Write: Channel 4-7 DMA master clear. Read: Intermediate register.

IO0DC Dma_ClrMask

Bits	Description
7:0	DmaClrMask . Read-write. Reset: 0. Channel 4-7 DMA clear mask.

IO0DE Dma_AllMask

Bits	Description
7:0	DmaAllMask . Read-write. Reset: 0. DMA2 mask register.

IO0F0 NCP Error

Writes to this port assert IGNNE# if FERR# is true. If FERR# is false, writes to this port do not assert IGNNE#. The first write will set WarmBoot.

Bits	Description
7	WarmBoot . Read; write-once. Cold reset: 0. Warm or cold boot indicator. 0=Cold. 1=Warm.
6:0	Reserved.

IO4D0 IntrEdgeControl

Bits	Description
15	IRQ15Control. Read-write. Reset: 0. 1=Level. 0=Edge.
14	IRQ14Control. Read-write. Reset: 0. 1=Level. 0=Edge.
13	Reserved.
12	IRQ12Control. Read-write. Reset: 0. 1=Level. 0=Edge.
11	IRQ11Control. Read-write. Reset: 0. 1=Level. 0=Edge.
10	IRQ10Control. Read-write. Reset: 0. 1=Level. 0=Edge.
9	IRQ9Control. Read-write. Reset: 0. 1=Level. 0=Edge.
8	IRQ8Control. Read-only. Reset: 0. Always edge.
7	IRQ7Control. Read-write. Reset: 0. 1=Level. 0=Edge.
6	IRQ6Control. Read-write. Reset: 0. 1=Level. 0=Edge.
5	IRQ5Control. Read-write. Reset: 0. 1=Level. 0=Edge.
4	IRQ4Control. Read-write. Reset: 0. 1=Level. 0=Edge.
3	IRQ3Control. Read-write. Reset: 0. 1=Level. 0=Edge.
2	Reserved.
1	IRQ1Control. Read-write. Reset: 0. 1=Level. 0=Edge.
0	IRQ0Control. Read-write. Reset: 0. 1=Level. 0=Edge.

IOC00 Pci_Intr_Index

Bits	Description
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7	PciIntrApic. Read-write. Reset: 0. 0=IRQ routing to PIC. 1=IRQ routing to IOAPIC.			
6:0	PciIntrIndex. Read-write. Reset: 0. PCI interrupt index. Selects which PCI interrupt to map.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00h	INTA#	18h	Reserved
	01h	INTB#	19h	Reserved
	02h	INTC#	1Fh-1Ah	Reserved
	03h	INTD#	20h	IMC INT0
	04h	GENINT1	21h	IMC INT1
	05h	GENINT2	22h	IMC INT2
	06h	Reserved	23h	IMC INT3
	07h	Reserved	24h	IMC INT4
	08h	Misc	25h	IMC INT5
	09h	Misc0	2Fh-26h	Reserved
	0Ah	Misc1	30h	Dev12h(USB) INTA#
	0Bh	Misc2	31h	Reserved
	0Ch	INTA from serial IRQ	32h	Dev13h(USB) INTA#
	0Dh	INTB from serial IRQ	33h	Reserved
	0Eh	INTC from serial IRQ	34h	Dev16h(USB) INTA#, Dev10h xHCI
	0Fh	INTD from serial IRQ	35h	Reserved
	10h	SCI	40h-36h	Reserved
	11h	SMBUS0	41h	SATA PCI interrupt
	12h	ASF	61h-42h	Reserved
	13h	HD audio	62h	GPIO controller interrupt
	14h	FC	7Fh-63h	Reserved
	15h	Reserved		
	16h	PerMon		
	17h	SD		

IOC01 Pci_Intr_Data

Bits	Description
7:0	PciIntrData. Read-write. Reset: 0.

IOC01_x0[7:0] PCI INT[H#,G#,F#,E#,D#,C#,B#,A#] Map

Bits	Description
7:5	Reserved.
4:0	Pci2IntrMap. Read-write. Reset: 1Fh. If (IOC00[PciIntrApic]==1) then Pci2IntrMap specifies mapping of INT[H#:A#] to APIC interrupt number. If (IOC00[PciIntrApic]==0) then Pci2IntrMap specifies mapping of INT[H#:A#] to PIC interrupt number.

IOC01_x08 Intr Misc Map

Bits	Description										
7:6	Pci2Intr15Map. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>IRQ15 mapped to legacy IDE</td></tr> <tr> <td>01b</td><td>IRQ15 mapped to SATA IDE</td></tr> <tr> <td>10b</td><td>IRQ15 mapped to SATA2</td></tr> <tr> <td>11b</td><td>IRQ15 come from Serial IRQ or PCI interrupt</td></tr> </table>	Bits	Definition	00b	IRQ15 mapped to legacy IDE	01b	IRQ15 mapped to SATA IDE	10b	IRQ15 mapped to SATA2	11b	IRQ15 come from Serial IRQ or PCI interrupt
Bits	Definition										
00b	IRQ15 mapped to legacy IDE										
01b	IRQ15 mapped to SATA IDE										
10b	IRQ15 mapped to SATA2										
11b	IRQ15 come from Serial IRQ or PCI interrupt										
5:4	Pci2Intr14Map. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>IRQ14 mapped to legacy IDE</td></tr> <tr> <td>01b</td><td>IRQ14 mapped to SATA IDE</td></tr> <tr> <td>10b</td><td>IRQ14 mapped to SATA2</td></tr> <tr> <td>11b</td><td>IRQ14 mapped to Serial IRQ or PCI interrupt</td></tr> </table>	Bits	Definition	00b	IRQ14 mapped to legacy IDE	01b	IRQ14 mapped to SATA IDE	10b	IRQ14 mapped to SATA2	11b	IRQ14 mapped to Serial IRQ or PCI interrupt
Bits	Definition										
00b	IRQ14 mapped to legacy IDE										
01b	IRQ14 mapped to SATA IDE										
10b	IRQ14 mapped to SATA2										
11b	IRQ14 mapped to Serial IRQ or PCI interrupt										
3	PciIntrIrq12. Read-write. Reset: 0. 0=IMC as IRQ12 input source. 1=Serial IRQ or PCI devices as IRQ12 input source.										
2	PciIntrIrq8. Read-write. Reset: 0. 0=RTC is IRQ8 input source. 1=Serial IRQ or PCI devices as IRQ8 input source.										
1	PciIntrIrq1. Read-write. Reset: 0. 0=IMC as IRQ1 input source. 1=Serial IRQ or PCI devices as IRQ1 input source.										
0	PciIntrIrq0. Read-write. Reset: 0. 0=8254 timer as IRQ0 input source. 1=Serial IRQ or PCI devices as IRQ0 input source.										

IOC01_x09 Intr Misc 0 Map

Bits	Description
7	IntrDelay. Read-write. Reset: 1. INTR 600 ns delay.
6	IRQ12FilterEnable. Read-write. Reset: 1. IRQ12 filter enable.
5	IRQ1FilterEnable. Read-write. Reset: 1. IRQ1 filter enable.
4	IrqInputEn. Read-write. Reset: 0. 0=Mask off IRQ input. 1=Enable IRQ input.
3	MaskIrq1Irq12. Read-write. Reset: 0. 0=Enable IRQ1 and IRQ12. 1=Mask off IRQ1 and IRQ12.
2	Merge_Ec_irq12. Read-write. Reset: 1. 0=Route serial IRQ12 to USB IRQ12 input. 1=Route IMC IRQ12 to USB IRQ12 input.
1	Merge_Ec_irq1. Read-write. Reset: 1. 0=Route serial IRQ1 to USB IRQ1 input. 1=Route IMC IRQ1 to USB IRQ1 input.
0	IntMap. Read-write. Reset: 1. 0=INT0 in IOAPIC comes from IRQ0 in PIC, INT2 in IOAPIC comes from INTR in PIC. 1=INT2 in IOAPIC comes from IRQ0 in PIC, INT0 in IOAPIC comes from INTR in PIC.

IOC01_x0A IntrMisc1Map

Bits	Description
7:0	HPET . Read-write. Reset: 0. Writes to this register update the bits in HPETx1[4:0:Step2]0[47:32] ; All 3 registers, HPETx100[47:32], HPETx120[47:32], and HPETx140[47:32], are updated at the same time. IOC01_x0A updates the lower 8 bits. IOC01_x0B updates the upper 8 bits.

IOC01_x0B IntrMisc2Map

Bits	Description
7:0	HPET . See: IOC01_x0A [HPET].

IOC01_x0[7F:C] PCI Interrupt Map

Bits	Description
7:5	Reserved.
4:0	Pci2IntrMap . Read-write. Reset: 1Fh. If (IOC00 [PciIntrApic]==1), then Pci2IntrMap specifies the APIC interrupt number that the corresponding PCI interrupt maps to. If (IOC00 [PciIntrApic]==0), then Pci2IntrMap specifies the PIC interrupt number that the corresponding PCI interrupt maps to. See IOC00 [Pci_Intr_Index] for the PCI interrupt list.

IOC14 Pci_Error

Bits	Description
7:4	Reserved.
3	PerrNmi . Read-write. Reset: 1. Enable NMI generation from PERR#. 0=Enable. 1=Disable.
2	SerrNmi . Read-write. Reset: 1. Enable NMI generation from SERR#. 0=Enable. 1=Disable.
1	PerrNmiStatus . Read-only. Reset: X. 1=NMI generation is enabled and PERR# is asserted due to a PCI data parity error. This bit is cleared by writing 1 to IO061 [2].
0	SerrNmiStatus . Read-only. Reset: X. 1=NMI generation is enabled and SERR# is asserted due to a PCI error. This bit is cleared by writing 1 to IO061 [2].

IOCD0 PM2_Index

Bits	Description
7:0	Pm2Index: Power management 2 index register . Read-write. Reset: 0. This register specifies the index of the power management 2 register. See Power Management Block 2 (PM2) Registers .

IOCD1 PM2_Data

Bits	Description
7:0	Pm2Data: Power management 2 data register. Read-write. Reset: 0. This register specifies the data read from/written to the power management 2 register pointed by IOCD0 . See Power Management Block 2 (PM2) Registers .

IOCD4 BIO SRAMIndex

Bits	Description
7:0	BiosRamIndex: BIOS RAM index register. Read-write. Reset: 0. This register specifies the index in the 256-byte BIOS RAM. Data in this RAM is preserved until RSMRST# is asserted or S5 power is lost.

IOCD5 BIO SRAM Data

Bits	Description
7:0	BiosRamData: BIOS RAM data register. Read-write. Reset: 0. This register specifies the data read from/written to the BIOS RAM pointed by IOCD4 .

IOCD6 PM_Index

Bits	Description
7:0	PmIndex: Power management index register. Read-write. Reset: 0. This register specifies the index of the power management register. See 3.26.13 [Power Management (PM) Registers] .

IOCD7 PM_Data

Bits	Description
7:0	PmData: Power management data register. Read-write. Reset: 0. This register specifies the data read from/written to the power management register pointed by IOCD6 . See 3.26.13 [Power Management (PM) Registers] .

IOCF9 System Reset Register

This register can be accessed through [PMxC5 \[CF9 Shadow\]](#).

Bits	Description
7:4	Reserved.
3	FullRst. Read-write. Reset: 0. 0=Assert reset signals only. 1=Place system in S5 state for 3 to 5 seconds.
2	RstCmd. Read-write; Cleared-by-hardware. Reset: 0. 1=Generate reset as specified by FullRst and SysRst.

1	SysRst. Read-write. Reset: 0. 0=Send an INIT HT message. 1=Reset as specified by FullRst.
0	Reserved.

3.26.2 AB Configuration Registers

AB Configuration registers are accessed indirectly through [ABx00 \[AB Index Register\]](#) and [ABx04 \[AB Data Register\]](#). The [ABx00/ABx04](#) register pair is located in IO address space as defined by [PMxE0](#).

ABx00 AB Index Register

Bits	Description								
31:29	RegSpace. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>101b-000b</td><td>Reserved</td></tr> <tr> <td>110b</td><td>ABCFG. A-Link Bridge Configuration</td></tr> <tr> <td>111b</td><td>Reserved</td></tr> </table> Once a valid register block address is written to this field, only valid register block addresses can be written to this field.	Bits	Definition	101b-000b	Reserved	110b	ABCFG. A-Link Bridge Configuration	111b	Reserved
Bits	Definition								
101b-000b	Reserved								
110b	ABCFG. A-Link Bridge Configuration								
111b	Reserved								
28:17	Reserved.								
16:0	RegAddr: Register Address. Read-write. Reset: 0.								

ABx04 AB Data Register

Bits	Description
31:0	Data: Register Address. Read-write. Reset: 0.

ABx04_x54 Misc Control 1

Bits	Description
31:25	Reserved.
24	BIClkGateEn. Read-write. Reset: 0. BIOS: See 2.17.11.3 . 1=Enable gating of B-Link clocks when idle is detected.
23:16	BIClkGateDelay. Read-write. Reset: 0. BIOS: See 2.17.11.3 . Specifies the number of B-Link clocks to delay before gating B-Link clocks after idle condition is detected.
15:5	Reserved.
4	DbgClkGateEn. Read-write. Reset: 0. BIOS: See 2.17.11.3 . 1=Enable gating of B-Link debug clocks.
3	Reserved.
2	UpSWrByteCntSbgMode. Read-write. Reset: 0. BIOS: See 2.17.11.4 . 1=Upstream 32/64 byte MST_BIF write requests will be issued only when all byte enables in the request are 1. This field is mutually exclusive with UpWr16BMode.
1	Reserved.
0	UpWr16BMode. Read-write. Reset: 1. BIOS: See 2.17.11.4 . Enables upstream writes to be limited to a maximum of 16-bytes per transaction. 0=Disable 16 Byte mode; AB can send DMA write request with length 16, 32, or 64 bytes. 1=Enable 16 Byte mode; AB will only send DMA write request with length 16 bytes. This bit should be mutually exclusive with UpSWrByteCntSbgMode. See ABx04_x204[Dma16ByteMode] .

ABx04_x58 B-Link RAB Control

Bits	Description
31	AlMemSDEn. Read-write. Reset: 0. BIOS: See 2.17.11.2. 1=Enable AB A-Link Memory Shut Down Feature. See ABx04_x10054[27:26] for idle counter settings.
30	Reserved.
29	BlMemSDEn. Read-write. Reset: 0. BIOS: See 2.17.11.2. 1=Enable AB B-Link Memory Shut Down Feature. See ABx04_x10054[27:26] for idle counter settings.
28:0	Reserved.

ABx04_x80 B-Link DMA Prefetch Control

Bits	Description										
31:22	Reserved.										
21:16	BiPrefMode. Read-write. Reset: 0. BIOS: 6. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[5:3]</td><td>Reserved.</td></tr> <tr> <td>[2]</td><td>Reserved, must be programmed to 1 to set B-Link prefetch mode</td></tr> <tr> <td>[1]</td><td>Reserved, must be programmed to 1 to set B-Link prefetch mode</td></tr> <tr> <td>[0]</td><td>Reserved.</td></tr> </table>	Bit	Definition	[5:3]	Reserved.	[2]	Reserved, must be programmed to 1 to set B-Link prefetch mode	[1]	Reserved, must be programmed to 1 to set B-Link prefetch mode	[0]	Reserved.
Bit	Definition										
[5:3]	Reserved.										
[2]	Reserved, must be programmed to 1 to set B-Link prefetch mode										
[1]	Reserved, must be programmed to 1 to set B-Link prefetch mode										
[0]	Reserved.										
15:8	Reserved.										
7:0	BiPrefEn. Read-write. Reset: 0. BIOS: 1. Enable B-Link prefetch on a per-device basis. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[7:1]</td><td>Reserved.</td></tr> <tr> <td>[0]</td><td>USB OHCI.</td></tr> </table>	Bit	Definition	[7:1]	Reserved.	[0]	USB OHCI.				
Bit	Definition										
[7:1]	Reserved.										
[0]	USB OHCI.										

ABx04_x90 BIF Control 0

Bits	Description
31:22	Reserved.
21	PpNpRfwCplCtrl. Read-write. Reset: 0. BIOS: 1. RFW completion control for posted pass non-posted.
20:0	Reserved.

ABx04_x94 MSI Control

Bits	Description
31:21	Reserved.
20	MsiAddrEn. Read-write. Reset: 0. BIOS: 1. 1=Enable AB to detect MSI sent upstream from FCH and inform power-management controller.
19:0	MsiAddr[39:20]. Read-write. Reset: 0. BIOS: See 2.17.11.1. Specifies MSI Address[39:20].

ABx04_x204 SBG Upstream Control

Bits	Description
31:1	Reserved.
0	Dma16ByteMode . Read-write. Reset: 0. To always split DMA write request to be 16 bytes request. 0=All the DMA write requests has the size that AB passes up. 1=Split the DMA write requests to be 16 bytes requests. Overrides ABx04_x54 [UpWr16BMode].

ABx04_x10054 A-Link Arbitration Control and Clock Control

Bits	Description
31:26	Reserved.
25	DbgClkGateEn . Read-write. Reset: 0. BIOS: See 2.17.11.3 . 1=Enable gating of A-Link debug clocks.
24	AIClkGateEn . Read-write. Reset: 0. BIOS: See 2.17.11.3 . 1=Enable gating of A-Link clocks when idle is detected.
23:16	AIClkGateDelay . Read-write. Reset: 0. BIOS: See 2.17.11.3 . Specifies the number of cycles to delay before gating A-Link clocks after idle condition is detected.
15:12	Reserved.
11:0	ArbCtl . Read-write. Reset: 0. BIOS: 7FFh. A-Link Arbiter Control. Enable the A-Link int_arbiter enhancement to allow the A-Link bandwidth to be used more efficiently

ABx04_x10090 Misc Control 3

Bits	Description
31:17	Reserved.
16	IOTrapDelayEnable: IO Trap Delay Enable . Read-write. Reset: 0. BIOS: 1. 1=Enable the IO trap delay.
15:0	Reserved.

3.26.3 SATA Controller

3.26.3.1 Device 11h Function 0 (SATA) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D11F0x00 Device/Vendor ID

Bits	Description								
31:16	DeviceID: Read-only. Reset: Product-specific. SATA controller has different device IDs for different drivers. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>7800h</td><td>SATA in IDE mode</td></tr> <tr> <td>7801h</td><td>SATA in AHCI mode with MS driver</td></tr> <tr> <td>7804h</td><td>SATA in AHCI mode with AMD driver</td></tr> </table>	Bits	Definition	7800h	SATA in IDE mode	7801h	SATA in AHCI mode with MS driver	7804h	SATA in AHCI mode with AMD driver
Bits	Definition								
7800h	SATA in IDE mode								
7801h	SATA in AHCI mode with MS driver								
7804h	SATA in AHCI mode with AMD driver								
15:0	VendorID: Vendor ID. Read-only. Reset: 1022h.								

D11F0x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; write-1-to-clear. Reset: 0. 1=The SATA controller detects a parity error.
30	SerrStatus: SERR# Status. Read; write-1-to-clear. Reset: 0. 1=The SATA controller detects a PCI address parity error.
29	ReceivedMasterAbort: Received Master Abort. Read; write-1-to-clear. Reset: 0. 1=The SATA controller aborts a PCI bus memory cycle while acting as a PCI master.
28	ReceivedTargetAbort: Received Target Abort. Read; write-1-to-clear. Reset: 0. 1=The SATA controller generated PCI cycle (SATA controller is the PCI master) is aborted by a PCI target.
27	SignaledTargetAbort: Signaled Target Abort. Read; write-1-to-clear. Reset: 0. 1=The SATA controller signals Target Abort.
26:25	DevselTiming: DEVSEL# Timing. Value: 1. These bits indicate DEVSEL# timing when performing a positive decode. 1=DEVSEL# is asserted to meet the medium timing.
24	DataParityError: Data Parity Error. Read; write-1-to-clear. Reset: 0. 1=SATA controller detects PERR# being asserted while acting as PCI master, regardless whether PERR# was driven by SATA controller or not.
23	FastBack2BackCapable: Fast Back-to-Back Capable. Value: 0.
22	Reserved.
21	Support66MHz: 66 MHz Support. Read-only. Reset: 1. 1=66 MHz capable.
20	CapabilitiesList: Capabilities List. Read-only. Reset: 1. 1=Capability list supported.
19	InterruptStatus: Interrupt Status. Read-only. Reset: 0. This bit reflects the state of the interrupt in the device/function. If (InterruptDisable==0) && (InterruptStatus==1), the device/function's INTx# signal is asserted. Setting InterruptDisable to 1 has no effect on the state of this bit.
18:11	Reserved.

10	InterruptDisable: Interrupt Disable. Read-write. Reset: 0. This bit disables the device/function from asserting INTx#. 0=Enable the assertion of the device/function's INTx# signal. 1=Disable the assertion of the device/function's INTx# signal.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Value: 0.
8	SERREnable: SERR# Enable. Read-write. Reset: 0. 1=The SATA controller asserts SERR# when it detects an address parity error && (PerrDetectionEnable==1). 0=SERR# is not asserted.
7	WaitCycleEnable: Wait Cycle Enable. Value: 0.
6	PerrDetectionEnable: PERR# Detection Enable. Read-write. Reset: 0. 1=The host controller asserts PERR# when it is the agent receiving data && when it detects a parity error. 0=PERR# is not asserted.
5	VGAPaletteSnoopEnable: VGA Palette Snoop Enable. Value: 0.
4	MemoryWriteandInvalidateEnable: Memory Write and Invalidate Enable. Value: 0.
3	SpecialCycleRecognitionEnable: Special Cycle Recognition Enable. Value: 0.
2	BusMasterEnable: Bus Master Enable. Read-write. Reset: 0. 1=Enable the device behaving as a bus master.
1	MemoryAccessEnable: Memory Access Enable. Read-write. Reset: 0. 1=Enable the SATA controller to respond to PCI memory space access.
0	IOAccessEnable: IO Access Enable. Read-write. Reset: 0. 1=Enable the SATA controller to respond to PCI IO space access.

D11F0x08 Revision ID/Class Code

SATA controller has different values for Subclass Code and ProgramIF[7:0] depending on its operating mode.

Table 255: SATA Controller Subclass Code and ProgramIF Settings

Subclass Code	ProgramIF[7:0]	Controller Type
01	8Fh/8Ah	IDE
06	01	AHCI

Bits	Description
31:24	ClassCode: Class Code. Value: 1. This is a Mass-Storage Controller.
23:16	SubclassCode. IF (D11F0x40[SubclassCodeWriteEnable]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 01h. BIOS: See 2.17.3.1. See Table 255.
15	ProgramIF[7]: Master IDE Device. IF (D11F0x40[SubclassCodeWriteEnable]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. BIOS: See 2.17.3.1. 1=Master IDE device in IDE mode. See Table 255.
14:12	Reserved.
11	ProgramIF[3]: Secondary Operating Mode Programmable. IF ((D11F0x40[SubclassCodeWriteEnable]) (D11F0x08[SubclassCode] == 01h)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. BIOS: See 2.17.3.1. 1=Both secondary operating modes are supported in IDE. See Table 255

10	ProgramIF[2]: Secondary Operating Mode. IF ((D11F0x40[SubclassCodeWriteEnable] == 1) (D11F0x08[SubclassCode] == 01h)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. BIOS: See 2.17.3.1. See Table 255 <div> <div>Bits</div> <div>Definition</div> <div>0b</div> <div>Compatibility Mode in IDE</div> <div>1b</div> <div>Native PCI Mode in IDE</div> </div>
9	ProgramIF[1]: Primary Operating Mode Programmable. IF ((D11F0x40[SubclassCodeWriteEnable] == 1) (D11F0x08[SubclassCode] == 01h)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. BIOS: See 2.17.3.1. 1=Both Primary operating modes are supported in IDE mode. See Table 255
8	ProgramIF[0]: Primary Operating Mode. IF ((D11F0x40[SubclassCodeWriteEnable]==1) (D11F0x08[SubclassCode] == 01h)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. BIOS: See 2.17.3.1. See Table 255. <div> <div>Bits</div> <div>Definition</div> <div>0b</div> <div>Compatibility Mode in IDE</div> <div>1b</div> <div>Native PCI Mode in IDE</div> </div>
7:0	RevisionID: Revision ID. Read-only. Reset: 39h.

D11F0x0C Header Type Register

Bits	Description
31	BISTCapable: BIST Capable. Value: 0. 0=No HBA related BIST function.
30	StartBIST: Start BIST. Read-write. Reset: 0. Programming this bit has no effect.
29:28	Reserved.
27:24	CompletionCode: Completion Code. Read-only. Reset: 0. Indicates the completion code status of BIST. A non-zero value indicates a failure.
23	MultiFunctionDevice: Multi-function device. Read-only. Reset: 0. 0=Single-function device.
22:16	HeaderType: Header Type. Read-only. Reset: 0. Since the SATA host controller is a single-function device, this field contains a value of 00h.
15:11	MasterLatencyTimer: Master Latency Timer. Read-write. Reset: 0. Specifies, in units of PCI bus clocks, the time slice allowed to SATA host controller for burst transactions.
10:8	Reserved.
7:4	CacheLineSize: Cache Line Size. Read-write. Reset: 0. 1= cache line size is 16 DW (64 byte).
3:0	Reserved.

D11F0x10 Primary IDE CS0 Base Address(BAR0)

Bits	Description
31:3	PrimaryIDECS0BaseAddress: Primary IDE CS0 Base Address. Read-write. Reset: 0. Base address[31:3] for Primary IDE Bus CS0 in IDE mode. This register is used for native mode only. See 3.26.3.2.1 [IDE Compatibility Mode and Native Mode Registers]
2:1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator. Value: 1. 1=Base address field in this register maps to the IO space.

D11F0x14 Primary IDE CS1 Base Address (BAR1)

Bits	Description
31:2	PrimaryIDECS1BaseAddress: Primary IDE CS1 Base Address. Read-write. Reset: 0. Base address[31:2] for Primary IDE Bus CS1 in IDE mode. This register is used for native mode only. See 3.26.3.2.1 [IDE Compatibility Mode and Native Mode Registers]
1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator. Value: 1. 1=Base address field in this register maps to the IO space.

D11F0x18 Secondary IDE CS0 Base Address (BAR2)

Bits	Description
31:3	SecondaryIDECS0BaseAddress: Secondary IDE CS0 Base Address. Read-write. Reset: 0. Base address[31:3] for Secondary IDE Bus CS0 in IDE mode. This register is used for native mode only. See 3.26.3.2.1 [IDE Compatibility Mode and Native Mode Registers]
2:1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator. Value: 1. 1=Base address field in this register maps to the IO space.

D11F0x1C Secondary IDE CS1 Base Address (BAR3)

Bits	Description
31:2	SecondaryIDECS1BaseAddress: Secondary IDE CS1 Base Address. Read-write. Reset: 0. Base address[31:2] for Secondary IDE Bus CS1 in IDE mode. This register is used for native mode only. See 3.26.3.2.1 [IDE Compatibility Mode and Native Mode Registers]
1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator. Value: 1. 1=Base address field in this register maps to the IO space.

D11F0x20 Bus Master Interface Register Base Address (BAR4)

Bits	Description
31:4	BusMasterInterfaceRegisterBaseAddress: Bus Master Interface Register Base Address. Read-write. Reset: 0. Base address[31:4] for Bus Master interface registers. See 3.26.3.2.2 [IDE Bus Master Registers] .
3:1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator. Value: 1. 1=Base address field in this register maps to the IO space.

D11F0x24 AHCI Base Address (BAR5)

Bits	Description
31:10	AHCIBaseAddress: AHCI Base Address[31:10] . Read-write. Reset: 0. Specifies base address[31:10] of the AHCI control register space. See 3.26.3.3 [SATA Memory Mapped AHCI Registers] .
9:1	Reserved.
0	ResourceTypeIndicator: Resource Type Indicator . Value: 0. 0=Base address field in this register maps to the memory space.

D11F0x2C Subsystem ID and Subsystem Vendor ID

Bits	Description
31:16	SubsystemID: Subsystem ID . Write-once; read. Reset: 0.
15:0	SubsystemVendorID: Subsystem Vendor ID . Write-once; read. Reset: 0.

D11F0x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapabilitiesPointer: Capabilities Pointer . Read-only. Reset: 60h. The first pointer of the Capability block.

D11F0x3C Interrupt Line

Bits	Description
31:24	MaximumLatency: Maximum Latency . Value: 0. Specifies the Maximum Latency time required before the SATA controller can start an access as a bus-master.
23:16	MinimumGrant: Minimum Grant . Value: 0. Specifies the desired settings for how long of a burst the SATA controller needs. The value specifies a period of time in units of 1/4 microseconds.
15:8	InterruptPin: Interrupt Pin . Value: 1.
7:0	InterruptLine: Interrupt Line . Read-write. Reset: 0. Identifies which input on the interrupt controller this function's PCI interrupt request pin as specified in InterruptPin is routed to.

D11F0x40 Misc Control

Bits	Description
31:24	Reserved.

23:16	SataPortDisable[7:0] . Read-write. Reset: 0. BIOS: See 2.17.3.6.1 . This field is bit-significant where bit 0 controls port 0. For each bit, 1=The corresponding port is disabled, link/transport layer clocks are shut down. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>1=Port 0 disable</td></tr> <tr> <td>[1]</td><td>1=Port 1 disable</td></tr> <tr> <td>[7:2]</td><td>Reserved</td></tr> </table>	Bit	Definition	[0]	1=Port 0 disable	[1]	1=Port 1 disable	[7:2]	Reserved
Bit	Definition								
[0]	1=Port 0 disable								
[1]	1=Port 1 disable								
[7:2]	Reserved								
15:14	Reserved.								
13	Reserved.								
12:3	Reserved.								
2:1	Reserved.								
0	SubclassCodeWriteEnable: Subclass Code Write Enable . Read-write. Reset: 0. BIOS: See 2.17.3.1 , 2.17.3.8.2 . 1=The following registers/fields are programmable: <ul style="list-style-type: none"> • D11F0x08[ProgramIF[7:0]] • D11F0x08[SubclassCode] • D11F0x50[MMC] 								

D11F0x44 Watch Dog Control And Status

Bits	Description
31:24	Reserved.
23:16	WatchdogCounter: Watchdog Counter . Read-write. Reset: 80h. BIOS: 20h. Specifies the timeout retry count for PCI downstream retries for SATA ports.
15:2	Reserved.
1	WatchdogTimeoutStatus: Watchdog Timeout Status . Read; write-1-to-clear. Reset: 0. 1=The watchdog counter has expired for PCI downstream transaction, and as a result, the transaction was aborted.
0	WatchdogEnable: Watchdog Enable . Read-write. Reset: 0. BIOS: 1. 1=Enable the watchdog counter for all the PCI downstream transactions for SATA ports.

D11F0x50 MSI Control

Bits	Description
31:24	Reserved.
23	C64: MSI 64-bit Address . Read-only. Reset: 1. 1=64-bit address is supported.
22:20	MME: Multiple Message Enable . Read-write. Reset: 0. Indicates the number of messages the HBA should assert. If the value programmed into this field exceeds the MMC field in this register, the results are undetermined.
19:17	MMC: Multiple Message Capable . Read-only. Reset: 2h. BIOS: See 2.17.3.8.2 . Indicates the number of messages the HBA wishes to assert.
16	MSIE: Message Signaled Interrupt Enable . Read-write. Reset: 0. 1=MSI is enabled and the traditional pins are not used to generate interrupts. 0=MSI operation is disabled and the traditional interrupt pins are used.

15:8	CapabilityNextPointer: Capability Next Pointer. Read-only. Reset: D0h. BIOS: 0.
7:0	CapabilityID: Capability ID. Read-only. Reset: 5h. Indicates this is MSI capability ID.

D11F0x54 MSI Address

Bits	Description
31:2	MsiAddress. Read-write. Reset: 0. Specifies the lower 32 bits of the system specified message address [31:2]. Always doubleword aligned.
1:0	Reserved.

D11F0x58 MSI Upper Address

Bits	Description
31:0	MsiUpperAddress. Read-write. Reset: 0. Specifies the upper 32 bits of the system specified message address [63:32].

D11F0x5C MSI Data

Bits	Description
31:16	Reserved.
15:0	MsiData. Read-write. Reset: 0. MSI Data.

D11F0x60 Power Management Capability

Bits	Description												
31:27	PSUP: PME Support. Read-only. Reset: 8. Indicates the states the can generate PME#. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>1=PME# can be generated form D0. Not supported; only interrupts are used.</td></tr> <tr> <td>[1]</td><td>1=PME# can be generated form D1. D1 is not supported.</td></tr> <tr> <td>[2]</td><td>1=PME# can be generated form D2. D2 is not supported.</td></tr> <tr> <td>[3]</td><td>1=PME# can be generated from D3hot state.</td></tr> <tr> <td>[4]</td><td>1=PME# can be generated form D3cold state. D3cold is not supported.</td></tr> </table>	Bit	Definition	[0]	1=PME# can be generated form D0. Not supported; only interrupts are used.	[1]	1=PME# can be generated form D1. D1 is not supported.	[2]	1=PME# can be generated form D2. D2 is not supported.	[3]	1=PME# can be generated from D3hot state.	[4]	1=PME# can be generated form D3cold state. D3cold is not supported.
Bit	Definition												
[0]	1=PME# can be generated form D0. Not supported; only interrupts are used.												
[1]	1=PME# can be generated form D1. D1 is not supported.												
[2]	1=PME# can be generated form D2. D2 is not supported.												
[3]	1=PME# can be generated from D3hot state.												
[4]	1=PME# can be generated form D3cold state. D3cold is not supported.												
26	D2S: D2 Support. Read-only. Reset: 0. 0=D2 state is not supported.												
25	D1S: D1 Support. Read-only. Reset: 0. 0=D1 state is not supported.												
24:22	AUXC: Aux Current. Value: 0. Reports the maximum Suspend well current required in D3COLD state.												
21	DSI: Device Specific Initialization. Read-only. Reset: 1. 1=Device-specific initialization is required.												
20	Reserved.												
19	PMEC: PME Clock. Read-only. Reset: 0. 0=PCI clock is not required to generate PME#.												
18:16	Version: Version. Read-only. Reset: 3h. Indicates support for Revision 1.2 of the PCI Power Management Specification.												

15:8	CapabilityNextPointer: Capability Next Pointer. Read-only. Reset: 70h. Points to SATA Capability.
7:0	CapabilityID: Capability ID. Read-only. Reset: 1. Indicates that this pointer is for PCI power management.

D11F0x64 PCI Power Management Control And Status

Bits	Description												
31:16	Reserved.												
15	PMES: PME Status. Read; Set-by-hardware; Write-1-to-clear. Cold reset: 0. This bit is set independent of PMEE according to PCI IPM. Writing '0' will have no effect. 1=PME# is generated by HBA.												
14:9	Reserved.												
8	PMEE: PME Enable. Read-write. Reset: 0. 1=The SATA controller asserts the PME# signal when PMES==1. 0=PME# assertion is disabled.												
7:4	Reserved.												
3	NSR: No soft reset. Value: 0. If the device transitions from D3hot to D0 due to system or bus segment reset and PME is supported and enabled, it returns to the device D0 state uninitialized with only PME context preserved regardless of this bit. 1=Devices do not perform an internal reset upon transitioning from D3hot to D0 because of Power-State commands; Configuration contexts is still preserved; Upon transitioning from D3hot to D0 Initialized state, no additional operating system intervention is required to preserve configuration context beyond writing the PowerState bits. 0=Devices do perform an internal reset upon transitioning from D3hot to D0 via software control of the PowerState bits; Configuration context is lost when performing the soft reset; Upon transition from the D3hot to D0 state, full re-initialization sequence is needed to return the device to D0 initialized.												
2	Reserved.												
1:0	PS: Power State. Read-write. Reset: 0. This field is used both to determine the current power state of the HBA and to set a new power state. The D1 and D2 states are not supported. When the HBA is in D3hot state, the configuration space is available, but the register memory spaces are not; Additionally, interrupts are blocked. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>D0 state.</td><td>10b</td><td>Reserved.</td></tr><tr><td>01b</td><td>Reserved.</td><td>11b</td><td>D3hot state.</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	D0 state.	10b	Reserved.	01b	Reserved.	11b	D3hot state.
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	D0 state.	10b	Reserved.										
01b	Reserved.	11b	D3hot state.										

D11F0x70 Serial ATA Capability Register 0

Bits	Description
31:24	Reserved.
23:20	MajorRevision: Major Revision. Read-only. Reset: 1. Major revision number of the SATA Capability Pointer implemented.
19:16	MinorRevision: Minor Revision. Read-only. Reset: 0. Minor revision number of the SATA Capability Pointer implemented.

15:8	CapabilityNextPointer: Capability Next Pointer. Read-only. Reset: 50h. BIOS: See 2.17.3.8.2 . Points to MSI capability.
7:0	CapabilityID: Capability ID. Read-only. Reset: 12h. Indicate that this pointer is for Serial ATA Capability.

D11F0x74 Serial ATA Capability Register 1

Bits	Description
31:24	Reserved.
23:4	BAROffset: BAR Offset. Read-only. Reset: 0. Indicates the offset into the BAR where the index/data pair are located in doubleword granularity.
3:0	BARLocation: BAR Location. Read-only. Reset: Fh. Indicates that index/data pair is implemented in doublewords directly following SATA Capability Register 1 in the PCI configuration space.

D11F0x78 IDP Index Register

Bits	Description
31:10	Reserved.
9:2	IDPIndex: IDP Index. Read-write. Reset: 0. This register selects the doubleword offset of the memory mapped AHCI register to be accessed.
1:0	Reserved.

D11F0x7C IDP Data Register

Bits	Description
31:0	IDPData: IDP Data. Read-write. Reset: 0h. This register is a window through which data is read or written to the memory mapped AHCI register pointed to by the D11F0x78 [IDP Index Register] . See 3.26.3.3 [SATA Memory Mapped AHCI Registers] . This is not a physical register, the default value for this field is 0000_0000h, once software programs a valid address in D11F0x78 [IDP Index Register] , it switches to the register value which IDPIndex pointing to. The AHCI registers can be accessed both through D11F0x24 [AHCI Base Address (BAR5)] and through this index/data pair.

D11F0x7C_x00 HBA Capabilities (CAP)

Bits	Description
31:0	Alias of SATAx00 .

D11F0x7C_x04 Global HBA Control (GHC)

Bits	Description
31:0	Alias of SATAx04 .

D11F0x7C_x08 Interrupt Status (IS)

Bits	Description
31:0	Alias of SATAx08 .

D11F0x7C_x0C Ports Implemented (PI)

Bits	Description
31:0	Alias of SATAx0C .

D11F0x7C_x10 AHCI Version (VS)

Bits	Description
31:0	Alias of SATAx10 .

D11F0x7C_x14 Command Completion Coalescing Control (CCC_CTL)

Bits	Description
31:0	Alias of SATAx14 .

D11F0x7C_x18 Command Completion Coalescing Ports (CCC_PORTS)

Bits	Description
31:0	Alias of SATAx18 .

D11F0x7C_x1C Enclosure Management Location (EM_LOC)

Bits	Description
31:0	Alias of SATAx1C .

D11F0x7C_x20 Enclosure Management Control (EM_CTL)

Bits	Description
31:0	Alias of SATAx20 .

D11F0x7C_x24 HBA Capabilities Extended (CAP2)

Bits	Description
31:0	Alias of SATAx24 .

D11F0x7C_x28 BIOS/OS Handoff Control and Status (BOHC)

Bits	Description
31:0	Alias of SATAx28 .

D11F0x7C_x1[8,0]0 Port 1,0 Command List Base Address (PxCLB)

Bits	Description
31:0	Alias of SATAx1[8,0]0 .

D11F0x7C_x1[8,0]4 Port 1,0 Command List Base Upper Address (PxCLBU)

Bits	Description
31:0	Alias of SATAx1[8,0]4 .

D11F0x7C_x1[8,0]8 Port 1,0 FIS Base Address (PxFB)

Bits	Description
31:0	Alias of SATAx1[8,0]8 .

D11F0x7C_x1[8,0]C Port 1,0 FIS Base Address Upper (PxFBU)

Bits	Description
31:0	Alias of SATAx1[8,0]C .

D11F0x7C_x1[9,1]0 Port 1,0 Interrupt Status (PxIS)

Bits	Description
31:0	Alias of SATAx1[9,1]0 .

D11F0x7C_x1[9,1]4 Port 1,0 Interrupt Enable (PxIE)

Bits	Description
31:0	Alias of SATAx1[9,1]4 .

D11F0x7C_x1[9,1]8 Port 1,0 Command and Status (PxCMD)

Bits	Description
31:0	Alias of SATAx1[9,1]8 .

D11F0x7C_x1[A,2]0 Port 1,0 Task File Data (PxTFD)

Bits	Description
31:0	Alias of SATAx1[A,2]0 .

D11F0x7C_x1[A,2]4 Port 1,0 Signature (PxSIG)

Bits	Description
31:0	Alias of SATAx1[A,2]4 .

D11F0x7C_x1[A,2]8 Port 1,0 Serial ATA Status (PxSSTS)

Bits	Description
31:0	Alias of SATAx1[A,2]8 .

D11F0x7C_x1[A,2]C Port 1,0 Serial ATA Control (PxSCTL)

Bits	Description
31:0	Alias of SATAx1[A,2]C .

D11F0x7C_x1[B,3]0 Port 1,0 Serial ATA Error (PxSERR)

Bits	Description
31:0	Alias of SATAx1[B,3]0 .

D11F0x7C_x1[B,3]4 Port 1,0 Serial ATA Active (PxSACT)

Bits	Description
31:0	Alias of SATAx1[B,3]4 .

D11F0x7C_x1[B,3]8 Port 1,0 Command Issue (PxCI)

Bits	Description
31:0	Alias of SATAx1[B,3]8 .

D11F0x7C_x1[B,3]C Port 1,0 SNotification (PxSNTF)

Bits	Description
31:0	Alias of SATAx1[B,3]C .

D11F0x7C_x1[C,4]0 Port 1,0 FIS-based Switching Control (PxFSB)

Bits	Description
31:0	Alias of SATAx1[C,4]0 .

D11F0x80 PHY Core Control 1BIOS: See [2.17.3.4](#).

Bits	Description												
31:9	Reserved.												
8	WRALL: Write Settings To All Ports. Write-only. Reset: 0. Allow software to simultaneously update all ports when writing to the port dependent PHY fine-tune setting register: D11F0x98 . 1=Writes to the PHY fine tune setting registers update all ports with the same value at the same time. 0=Writes to the PHY fine tune setting registers only update individual port selected by PN.												
7:6	Reserved.												
5:4	GEN: Generation Speed. Read-write. Reset: 1. Selects the Generation Speed when software reads/writes to the generation speed dependent PHY fine-tune setting register: D11F0x98 . <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>Reserved</td><td>10b</td><td>Gen 2</td></tr><tr><td>01b</td><td>Gen 1</td><td>11b</td><td>Gen 3</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	10b	Gen 2	01b	Gen 1	11b	Gen 3
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	Reserved	10b	Gen 2										
01b	Gen 1	11b	Gen 3										
3	Reserved.												
2:0	PN: PHY Fine Tune Target Port. Read-write. Reset: 0. Selects the port when software reads/writes to the port dependent PHY fine-tune setting register: D11F0x98 . <table><tr><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>Port 0 is selected</td></tr><tr><td>01b</td><td>Port 1 is selected</td></tr><tr><td>7h-2h</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Definition</u>	00b	Port 0 is selected	01b	Port 1 is selected	7h-2h	Reserved				
<u>Bits</u>	<u>Definition</u>												
00b	Port 0 is selected												
01b	Port 1 is selected												
7h-2h	Reserved												

D11F0x84 PHY Core Control 2

Bits	Description						
31	Reserved.						
30	DShtDwn: PHY PLL Dynamic Shutdown. Read-write. Reset: 1. Turn on/off the advanced power saving feature. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0b</td><td>No PLL dynamic shutdown; SATA PHY PLL consumes power even though all the ports are inactive.</td></tr> <tr> <td>1b</td><td>SATA PHY PLL will dynamically shutdown when all the ports are inactive. This inactivity includes Slumber Mode and port disable, but excludes Partial Mode.</td></tr> </table>	Bits	Definition	0b	No PLL dynamic shutdown; SATA PHY PLL consumes power even though all the ports are inactive.	1b	SATA PHY PLL will dynamically shutdown when all the ports are inactive. This inactivity includes Slumber Mode and port disable, but excludes Partial Mode.
Bits	Definition						
0b	No PLL dynamic shutdown; SATA PHY PLL consumes power even though all the ports are inactive.						
1b	SATA PHY PLL will dynamically shutdown when all the ports are inactive. This inactivity includes Slumber Mode and port disable, but excludes Partial Mode.						
29:27	Reserved.						

26	S5ShadowLdDis: S5 Shadow Register Reload Disable. Read-write. Reset: 1. BIOS: See 2.17.3.7 . 1=Not to load S5 shadow registers back to PHY related control registers when S0 domain loses power other than cold boot. 0=Turn on shadow register reloading.
25:3	Reserved.
2	RSTB: PHY Global Reset. Read-write. Reset: 1. BIOS: See 2.17.3.5 . 0=Reset all port logic in PHY.
1:0	Reserved.

D11F0x88 PHY Global Control 1

Bits	Description
31:28	PIIVcoTune: PLL VCO Range Select Bits. Read-write. Reset: 0. BIOS: See 2.17.3.3 . PLL VCO range select bits.
27:0	Reserved.

D11F0x8C PHY Global Control 2

Bits	Description
31:8	Reserved.
7:0	PLL_CLKF: PLL Clock Divider Setting. Read-write. Reset: 7Dh. BIOS: See 2.17.3.5 . Feedback clock divider setting.

D11F0x98 PHY Fine Tune PortX GenX Setting

This register is both port and generation speed sensitive. Software must program [D11F0x80\[PN\]](#) to select port and [D11F0x80\[GEN\]](#) to select generation speed before accessing this register.

Bits	Description
31:17	Reserved.
16:12	TX_SLEW_CNTRL: Transmitter Output Slew Control. Read-write. Reset: 3h. BIOS: See 2.17.3.4 . Rise/Fall time is controlled by the combined force of TX_DRV_STR, TX_SLEW_CNTRL, and TX_DEEMPH_STR. Depending on the channel loss, the value of TX_SLEW_CNTRL and TX_DEEMPH_STR may have to be adjusted based on package and board design.
11:0	Reserved.

D11F0x9C PortX Setting 2

Bits	Description
31:12	Reserved.

11:9	RX_SQDET_TH: Squelch Detector Threshold Control. Read-write. Reset: IF (D11F0x80[GEN]==1) THEN 4h. ELSEIF (D11F0x80[GEN]==2) THEN 4h. ELSEIF (D11F0x80[GEN]==3) THEN 4h. ENDIF. BIOS: See 2.17.3.4. Specifies the squelch detector threshold adjustment.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	0	100b	+25 mV
	001b	+6 mV	101b	+30 mV
	010b	-16 mV	110b	+14 mV
	011b	-7 mV	111b	+20 mV
8:0	Reserved.			

D11F0xB4 PortX BIST Control/Status

Software must program D11F0xB7 [PortX BIST Port Select] to select the port before reading from or writing to this register.

Bits	Description																										
15	Reserved.																										
14	Reserved.																										
13:12	PortXLinkBistSpeed: PortX Link BIST Speed. Read-write. Reset: 0. PHY PortX speed control for Link BIST mode. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>Gen 1</td><td>10b</td><td>Gen 2</td></tr><tr><td>01b</td><td>Gen 1</td><td>11b</td><td>Gen 3</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	Gen 1	10b	Gen 2	01b	Gen 1	11b	Gen 3														
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																								
00b	Gen 1	10b	Gen 2																								
01b	Gen 1	11b	Gen 3																								
11:6	Reserved.																										
5:2	PortXLinkBistPattern: PortX Link BIST Pattern. Read-write. Reset: 0. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0000b</td><td>Pseudo-random with ALIGN insertion (when Error Count is used, must choose this pattern).</td></tr><tr><td>0001b</td><td>D10.2 Highest frequency (for Rx eye diagram measurement).</td></tr><tr><td>0010b</td><td>SYNC primitive (for Rx eye diagram measurement).</td></tr><tr><td>0011b</td><td>Reserved.</td></tr><tr><td>0100b</td><td>Mid Frequency Test Pattern (MFTP).</td></tr><tr><td>0101b</td><td>Reserved.</td></tr><tr><td>0110b</td><td>Reserved.</td></tr><tr><td>0111b</td><td>Forced T-mode enable. T-mode is defined as Far end transmit only mode without Device initiating. In T-mode, the BIST pattern generated is based on the values programed in D11F0xBC and D11F0xC0.</td></tr><tr><td>1000b</td><td>Reserved.</td></tr><tr><td>1001b</td><td>Reserved.</td></tr><tr><td>1010b</td><td>Reserved.</td></tr><tr><td>1111b-1011b</td><td>Reserved.</td></tr></table>	<u>Bits</u>	<u>Definition</u>	0000b	Pseudo-random with ALIGN insertion (when Error Count is used, must choose this pattern).	0001b	D10.2 Highest frequency (for Rx eye diagram measurement).	0010b	SYNC primitive (for Rx eye diagram measurement).	0011b	Reserved.	0100b	Mid Frequency Test Pattern (MFTP).	0101b	Reserved.	0110b	Reserved.	0111b	Forced T-mode enable. T-mode is defined as Far end transmit only mode without Device initiating. In T-mode, the BIST pattern generated is based on the values programed in D11F0xBC and D11F0xC0 .	1000b	Reserved.	1001b	Reserved.	1010b	Reserved.	1111b-1011b	Reserved.
<u>Bits</u>	<u>Definition</u>																										
0000b	Pseudo-random with ALIGN insertion (when Error Count is used, must choose this pattern).																										
0001b	D10.2 Highest frequency (for Rx eye diagram measurement).																										
0010b	SYNC primitive (for Rx eye diagram measurement).																										
0011b	Reserved.																										
0100b	Mid Frequency Test Pattern (MFTP).																										
0101b	Reserved.																										
0110b	Reserved.																										
0111b	Forced T-mode enable. T-mode is defined as Far end transmit only mode without Device initiating. In T-mode, the BIST pattern generated is based on the values programed in D11F0xBC and D11F0xC0 .																										
1000b	Reserved.																										
1001b	Reserved.																										
1010b	Reserved.																										
1111b-1011b	Reserved.																										
1	Reserved.																										
0	PortXLinkBistEnable: PortX Link BIST Enable. Read-write. Reset: 0. 1=PortX is in link BIST mode overriding normal operation and device OOB is ignored by host. To resume normal operation, this bit needs to be cleared to 0 and a port reset is required.																										

D11F0xB7 PortX BIST Port Select

Bits	Description
7:2	Reserved.
1:0	PortXBistPortSelect: PortX BIST Port Select. Read-write. Reset: 0. This register is bit significant. When the bit is 1, it indicates the port that software will read from/write to during link BIST. For reads, the port is determined by the last significant bit with value 1 in this field. For writes, the port(s) is determined by the any bit with value 1 in this field. This register must be programmed before writing to/reading from D11F0xB4 to avoid reading from/written to an un-expected port.

D11F0xBC T-Mode BIST Transit Pattern DW1

Bits	Description
31:0	TmodeBistTransitPatternDW1: T-mode BIST Transit Pattern DW1. Read-write. Reset: 0. Transit Pattern DW1. See D11F0xB4 [PortXLinkBistPattern] for T-mode enable.

D11F0xC0 T-Mode BIST Transit Pattern DW2

Bits	Description
31:0	TmodeBistTransitPatternDW2: T-mode BIST Transit Pattern DW2. Read-write. Reset: 0. Transit Pattern DW2. See D11F0xB4 [PortXLinkBistPattern] for T-mode enable.

D11F0xC4 T-Mode BIST Transit Control

Bits	Description
31:3	Reserved.
2	TmodePbit: T-mode P bit. Read-write. Reset: 0. The transmit primitives bit.
1	TmodeSbit: T-mode S bit. Read-write. Reset: 0. Scrambling Bypass.
0	TmodeAbit: T-mode A bit. Read-write. Reset: 0. ALIGN primitives bypass mode.

D11F0xD0 Advanced Features Capability Register 0

Bits	Description
31:26	Reserved.
25	FlrCap. Read-only. Reset: 1. 1=Indicates support for Function Level Reset (FLR).
24	TpCap. Read-only. Reset: 1. 1=Indicates support for the Transactions Pending (TP) bit (D11F0xD4 [TP]). TP must be supported if FLR is supported.
23:16	Length. Read-only. Reset: 6h. Advanced Feature (AF) Structure Length (Bytes).
15:8	NextPtr: Next pointer. Read-only. Reset: 0. 0=End of list.
7:0	CapID: Capability ID. Read-only. Reset: 13h. Identifies the function being Advanced Feature (AF) capable.

D11F0xD4 Advanced Features Capability Register 1

Bits	Description
31:16	Reserved.
15:9	Reserved.
8	TP: Transactions Pending. Read-only; updated-by-hardware. Reset: 0. 1=The function has issued one or more non-posted transactions which have not been completed, including non-posted transactions that a target has terminated with retry. 0=All non-posted transactions have been completed.
7:1	Reserved.
0	InitiateFlr. Read-write; RAZ. Reset: 0. 1=Initiate Function Level Reset (FLR).

D11F0xE0 PCI Target Control TimeOut Counter

Bits	Description
15:8	Reserved.
7:0	Count: PCI Target Control Timeout Count. Read-write. Reset: 80h. This field specifies the PCI target control timeout count used to clear any stale target commands to the host controller. Granularity is 15.5 us (Timeout Counter = Count * 15.5 us). The counter is disabled if the count is programmed to 0.

3.26.3.2 SATA IO Registers**3.26.3.2.1 IDE Compatibility Mode and Native Mode Registers**

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention.

Compatibility Mode is selected by [D11F0x08](#)[ProgramIF[0], ProgramIF[2]]==0 respectively. In Compatibility Mode the IO address is forced to the legacy compatible address. The same group of registers can be specified as Native Mode by [D11F0x08](#)[ProgramIF[0], ProgramIF[2]]==1, respectively. In Native Mode, the IO address is specified by [D11F0x10](#), [D11F0x14](#), [D11F0x18](#) and [D11F0x1C](#).

Table 256: IDE Compatibility Mode and Native Mode Address Mapping

Compatibility Mode: Interface, IO Address	Native Mode: Interface, BAR+Offset	Read Function	Write Function	Register
Primary, 1F0h	Primary, D11F0x10 +0	Data (16 bit)	Data (16 bit)	IDE[0]_x00
Primary, 1F1h	Primary, D11F0x10 +1	Error	Feature	IDE[0]_x01
Primary, 1F2h	Primary, D11F0x10 +2	Sector Count	Sector Count	IDE[0]_x02
Primary, 1F3h	Primary, D11F0x10 +3	Sector Number	Sector Number	IDE[0]_x03
Primary, 1F4h	Primary, D11F0x10 +4	Cylinder Low	Cylinder Low	IDE[0]_x04
Primary, 1F5h	Primary, D11F0x10 +5	Cylinder High	Cylinder High	IDE[0]_x05
Primary, 1F6h	Primary, D11F0x10 +6	Drive/Head	Drive/Head	IDE[0]_x06
Primary, 1F7h	Primary, D11F0x10 +7	Status	Command	IDE[0]_x07
Primary, 3F6h	Primary, D11F0x14 +2	Alternate Status	Device Control	IDEA[0]_x02
Secondary, 170h	Secondary, D11F0x18 +0	Data (16 bit)	Data (16 bit)	IDE[1]_x00

Table 256: IDE Compatibility Mode and Native Mode Address Mapping

Compatibility Mode: Interface, IO Address	Native Mode: Interface, BAR+Offset	Read Function	Write Function	Register
Secondary, 171h	Secondary, D11F0x18+1	Error	Feature	IDE[1]_x01
Secondary, 172h	Secondary, D11F0x18+2	Sector Count	Sector Count	IDE[1]_x02
Secondary, 173h	Secondary, D11F0x18+3	Sector Number	Sector Number	IDE[1]_x03
Secondary, 174h	Secondary, D11F0x18+4	Cylinder Low	Cylinder Low	IDE[1]_x04
Secondary, 175h	Secondary, D11F0x18+5	Cylinder High	Cylinder High	IDE[1]_x05
Secondary, 176h	Secondary, D11F0x18+6	Drive/Head	Drive/Head	IDE[1]_x06
Secondary, 177h	Secondary, D11F0x18+7	Status	Command	IDE[1]_x07
Secondary, 376h	Secondary, D11F0x1C+2	Alternate Status	Device Control	IDEA[1]_x02

IDE[1:0]x00 IDE DATA

Bits	Description
15:0	Data . Read-write. Reset: 0. Accesses to this register must be 16 bit. Addressing as an 8 bit register results in IDE[1:0]x00[15:8] aliasing to IDE[1:0]x01 .

IDE[1:0]x01 Feature and Error

Bits	Description
7:0	FeatureError . Read-write. Reset: 0.

IDE[1:0]x02 Sector Count

Bits	Description
7:0	SectorCount . Read-write. Reset: 0.

IDE[1:0]x03 Sector Number

Bits	Description
7:0	SectorNumber . Read-write. Reset: 0.

IDE[1:0]x04 Cylinder Low

Bits	Description
7:0	CylinderLow . Read-write. Reset: 0.

IDE[1:0]x05 Cylinder High

Bits	Description
7:0	CylinderHigh . Read-write. Reset: 0.

IDE[1:0]x06 Drive and Head

Bits	Description
7:0	DriveHead . Read-write. Reset: 0.

IDE[1:0]x07 Command and Status

Bits	Description
7:0	CommandStatus . Read-write. Reset: 0.

IDEA[1:0]x02 Device Control and Alternate Status

Bits	Description
7:0	DevCtrlAltStatus . Read-write. Reset: 0.

3.26.3.2.2 IDE Bus Master Registers

See section 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention.

IDE_BMx0[8,0] Bus Master IDE Command

Primary and Secondary Bus Master IDE Command registers.

Bits	Description						
7:4	Reserved.						
3	BusMasterReadWrite: Bus Master Read/Write . Read-write. Reset: 0. This bit should not change during Bus Master transfer cycle, even if terminated by Bus Master IDE Stop. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>0b</td><td>Memory to IDE.</td></tr> <tr> <td>1b</td><td>IDE to memory.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0b	Memory to IDE.	1b	IDE to memory.
<u>Bits</u>	<u>Definition</u>						
0b	Memory to IDE.						
1b	IDE to memory.						
2:1	Reserved.						
0	BusMasterIDEStartStop: Bus Master IDE Start/Stop . Read-write. Reset: 0. This bit will not be reset by interrupt from IDE device. This must be reset by software (device driver). <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>0b</td><td>Stop.</td></tr> <tr> <td>1b</td><td>Start.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0b	Stop.	1b	Start.
<u>Bits</u>	<u>Definition</u>						
0b	Stop.						
1b	Start.						

IDE_BMx0[A,2] Bus-master IDE Status

Primary and Secondary Bus Master IDE Status registers.

Bits	Description						
7	SimplexOnly: Simplex Only. Value: 0.						
6	SlaveDeviceDMACapable: Slave Device DMA Capable. Read-write. Reset: 0. Device 1 (Slave) DMA capable.						
5	MasterDeviceDMACapable: Master Device DMA Capable. Read-write. Reset: 0. Device 0 (Master) DMA capable.						
4:3	Reserved.						
2	IDEInterrupt: IDE Interrupt. Read-write. Reset: 0. 1=An IDE device has asserted its interrupt line. IRQ14 is used for the primary channel, and IRQ15 is used for the secondary channel. If the Interrupt Status bit is set to 0, by writing a 1 to this bit while the interrupt line is still at the active level, this bit will remain 0 until another assertion edge is detected on the interrupt line.						
1	BusMasterDMAError: Bus Master DMA Error. Read; write-1-to-clear. Reset: 0. 1=The IDE host controller encounters a target abort, master abort, or parity error while transferring data on the PCI bus.						
0	BusMasterActive: Bus Master Active. Read-only; updated-by-hardware. Reset: 0. Bus Master IDE active. This bit is set to 1 when IDE_BMx0[8,0][0]==1 . This bit is set to 0 when IDE_BMx0[8,0][0]==0 or the last transfer for a region is performed. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0b</td><td>Not active.</td></tr> <tr> <td>1b</td><td>Active.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0b	Not active.	1b	Active.
<u>Bits</u>	<u>Definition</u>						
0b	Not active.						
1b	Active.						

IDE_BMx0[C,4] Descriptor Table Pointer

Primary and Secondary Bus Master IDE Descriptor Table Pointer register.

Bits	Description
31:2	DescriptorTableBaseAddress: Descriptor Table Base Address. Read-write. Reset: 0. These bits correspond to Address [31:2].
1:0	Reserved.

3.26.3.3 SATA Memory Mapped AHCI Registers

These are the AHCI memory mapped registers. The base address is defined by [D11F0x24 \[AHCI Base Address \(BAR5\)\]](#). See section [3.1 \[Register Descriptions and Mnemonics\]](#) for a description of the register naming convention.

3.26.3.3.1 Generic Host Control Registers

SATAx00 HBA Capabilities (CAP)

Bits	Description												
31	S64A: Supports 64-bit Addressing. Read-only. Reset: 1. Indicates whether HBA can access 64-bit data structures. 1=HBA will make the 32-bit upper bits of the port DMA Descriptor, the PRD Base, and each PRD entry read/write.												
30	SNCQ: Supports Native Command Queuing. Read-only. Reset: 1. Indicates whether HBA supports Serial ATA native command queuing. 1=HBA can handle DMA Setup FISes natively, and can handle the auto-activate optimization through that FIS.												
29	SSNTF: Supports SNotification Register. Read-only. Reset: 1. 1=HBA supports the SATAx1[B,3]C [Port 1,0 SNotification (PxSNTF)] register and its associated functionality.												
28	SMPS: Supports Mechanical Presence Switch. Read-only. Reset: 1. 1=HBA supports mechanical presence switches on its ports for use in hot plug operations. 0=This function is not supported. This value is loaded by the BIOS prior to OS initialization.												
27	SSS: Supports Staggered Spin-up. Read-only. Reset: 0. 0=This function is not supported. This value is loaded by the BIOS prior to OS initialization.												
26	SALP: Supports Aggressive Link Power Management. Read-only. Reset: 1. 1=HBA can support auto-generating link requests to the Partial or Slumber states when there are no commands to process.												
25	SAL: Supports Activity LED. Read-only. Reset: 1. 1=HBA supports a single activity indication output pin; This pin can be connected to an LED on the platform to indicate device activity on any drive.												
24	SCLO: Supports Command List Override. Read-only. Reset: 1. 1=HBA supports the SATAx1[9,1]8[CLO] bit and its associated function.												
23:20	<p>ISS: Interface Speed Support. Read-only. Reset: 3h. Indicates the maximum speed HBA can support on its ports. These encodings match the system software programmable SATAx1[A,2]C[SPD] field. Values are:</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000b</td><td>Reserved</td></tr> <tr> <td>0001b</td><td>Gen1 (1.5 Gbps)</td></tr> <tr> <td>0010b</td><td>Gen1 and Gen2 (3 Gbps)</td></tr> <tr> <td>0011b</td><td>Gen1 and Gen2 and Gen3 (6 Gbps)</td></tr> <tr> <td>1111b-0100b</td><td>Reserved</td></tr> </table>	Bits	Definition	0000b	Reserved	0001b	Gen1 (1.5 Gbps)	0010b	Gen1 and Gen2 (3 Gbps)	0011b	Gen1 and Gen2 and Gen3 (6 Gbps)	1111b-0100b	Reserved
Bits	Definition												
0000b	Reserved												
0001b	Gen1 (1.5 Gbps)												
0010b	Gen1 and Gen2 (3 Gbps)												
0011b	Gen1 and Gen2 and Gen3 (6 Gbps)												
1111b-0100b	Reserved												
19	SNZO: Supports Non-Zero DMA Offsets. Read-only. Reset: 0. 0=Indicates HBA can not support non-zero DMA offsets for DMA Setup FISes.												
18	SAM: Supports AHCI mode only. Read-only. Reset: 0. The SATA controller may optionally support AHCI access mechanisms only. 0=Indicates that in addition to the native AHCI mechanism (via AHCI BAR5), the SATA controller implements a legacy, task-file based register interface such as SFF-8038i. 1=Indicates the SATA controller does not implement a legacy, task-file based register interface.												
17	SPM: Supports Port Multiplier. Read-only. Reset: 1. Indicates whether HBA can support a port multiplier. 1=A port multiplier using command-based switching is supported. 0=A port multiplier is not supported, and a port multiplier may not be attached to this HBA.												
16	FBSS: FIS-based Switching Supported. Read-only. Reset: 1. 1=Indicates HBA supports Port Multiplier FIS-based switching. 0=Indicates HBA does not support FIS-based switching.												

15	PMD: PIO Multiple DRQ Block. Read-only. Reset: 1. 0=HBA only supports single DRQ block data transfers for the PIO command protocol. 1=HBA supports multiple DRQ block data transfers for the PIO command protocol.
14	SSC: Slumber State Capable. Read-only. Reset: 1. Indicates whether HBA can support transitions to the Slumber state. 0=Software must not allow the HBA to initiate transitions to the Slumber state via aggressive link power management nor the SATAx1[9,1]8[ICC] field in each port, and the SATAx1[A,2]C[IPM] field in each port must be programmed to disallow device initiated Slumber requests. 1=HBA and device initiated Slumber requests can be supported.
13	PSC: Partial State Capable. Read-only. Reset: 1. Indicates whether HBA can support transitions to the Partial state. 0=Software must not allow HBA to initiate transitions to the Partial state via aggressive link power management nor the SATAx1[9,1]8[ICC] field in each port, and the SATAx1[A,2]C[IPM] field in each port must be programmed to disallow device initiated Partial requests. 1=HBA and device initiated Partial requests can be supported.
12:8	NCS: Number of Command Slots. Read-only. Reset: 1Fh. 0's based value indicate the number of command slots per port supported by this HBA. A minimum of 1 and a maximum of 32 slots per port can be supported. The same number of command slots are available on each implemented port.
7	CCCS: Command Completion Coalescing Supported. Read-only. Reset: 1. 0=Indicates that HBA does not support command completion coalescing and SATAx14 [Command Completion Coalescing Control (CCC_CTL)] and SATAx18 [Command Completion Coalescing Ports (CCC_PORTS)] are not implemented. 1=Indicates that HBA supports command completion coalescing and HBA has implemented the SATAx14 [Command Completion Coalescing Control (CCC_CTL)] and the SATAx18 [Command Completion Coalescing Ports (CCC_PORTS)] global HBA registers.
6	EMS: Enclosure Management Supported. Read-only. Reset: 0b. 1=Indicates that HBA supports enclosure management and has implemented the SATAx1C [Enclosure Management Location (EM_LOC)] and SATAx20 [Enclosure Management Control (EM_CTL)] global HBA registers. 0=Indicates that the HBA does not support enclosure management and the SATAx1C [Enclosure Management Location (EM_LOC)] and SATAx20 [Enclosure Management Control (EM_CTL)] global HBA registers are not implemented.
5	SXS: Supports External SATA. Read-only. Reset: 0. 1=Indicates that HBA has one or more Serial ATA ports that have a signal-only connector (i.e. power is not part of that connector) that is externally accessible. 0=Indicates that the HBA has no Serial ATA ports that have a signal-only connector externally accessible. If this bit is set to 1, software may refer to the SATAx1[9,1]8[ESP] bit to determine whether a specific port has its signal connector externally accessible as a signal-only connector.
4:0	NP: Number of Ports. Read-only. Reset: 3h. 0's based value indicating the maximum number of ports supported by the HBA silicon. A maximum of 32 ports can be supported. A value of 0, indicating one port, is the minimum requirement. Note that the number of ports indicated in this field may be more than the number of ports indicated in the SATAx0C[PI] .

SATAx04 Global HBA Control (GHC)

Bits	Description
31	AE: AHCI Enable. Read-write. Reset: 0. 1=Indicates that communication to HBA shall be via AHCI mechanisms. 0=Software shall only communicate with HBA using legacy mechanisms; FISes are not posted to memory, and no commands are sent via AHCI mechanisms. This can be used by an HBA that supports both legacy mechanisms and AHCI to know when the HBA is running under an AHCI driver. Software shall set this bit to 1 before accessing other AHCI registers.
30:3	Reserved.

2	<p>MRSM: MSI Revert to Single Message. Read-only. Reset: 0. 1=HBA requested more than one MSI vector but has reverted to using the first vector only. 0=HBA has not reverted to single MSI mode (i.e., hardware is already in single MSI mode, software has allocated the number of messages requested, or hardware is sharing interrupt vectors if D11F0x50[MME]<D11F0x50[MMC]). HBA may revert to single MSI mode when the number of vectors allocated by the host is less than the number requested. This bit shall only be set to 1 when the following conditions hold:</p> <ul style="list-style-type: none"> • D11F0x50[MSIE]=1 (MSI is enabled) • D11F0x50MMC]>0 (multiple messages requested) • D11F0x50MME]>0 (more than one message allocated) • D11F0x50MME]!=D11F0x50[MMC] (messages allocated not equal to number requested) <p>When this bit is set to 1, single MSI mode operation is in use and software is responsible for clearing bits in the IS register to clear interrupts. This bit shall be cleared to 0 by hardware when any of the four conditions stated is false. This bit is also cleared to 0 when D11F0x50[MSIE] = 1 and D11F0x50[MME] = 0h. In this case, hardware has been programmed to use single MSI mode, and is not “reverting” to that mode.</p>
1	<p>IE: Interrupt Enable. Read-write. Reset: 0. This global bit enables interrupts from HBA. 0=All interrupt sources from all ports are disabled. 1=Interrupts are enabled.</p>
0	<p>HR: HBA Reset. Read; write-1-only; cleared-by-hardware. Reset: 0. When set by software, this bit causes an internal reset of HBA. All state machines that relate to data transfers and queuing shall return to an idle condition, and all ports shall be re-initialized via COMRESET (if staggered spin-up is not supported). If staggered spin-up is supported, then it is the responsibility of software to spin-up each port after the reset has completed. When HBA has performed the reset action, it shall reset this bit to 0.</p>

SATAx08 Interrupt Status (IS)

Bits	Description										
31:0	<p>IPS: Interrupt Pending Status. Read; write-1-to-clear. Reset: 0. This register is bit significant where bit 0 corresponds to port 0. For each bit, 1=The corresponding port has an interrupt pending. Software can use this information to determine which ports require service after an interrupt. The IPS[X] bit is only defined for ports that are implemented or for the command completion coalescing interrupt defined by SATAx14[INT]. All other bits are reserved.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>Port 0 has pending interrupt</td></tr> <tr> <td>[1]</td><td>Port 1 has pending interrupt</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>[31]</td><td>Port 31 has pending interrupt</td></tr> </table>	Bit	Definition	[0]	Port 0 has pending interrupt	[1]	Port 1 has pending interrupt	[31]	Port 31 has pending interrupt
Bit	Definition										
[0]	Port 0 has pending interrupt										
[1]	Port 1 has pending interrupt										
...	...										
[31]	Port 31 has pending interrupt										

SATAx0C Ports Implemented (PI)

Bits	Description								
31:0	<p>PI[31:0]: Port Implemented. Read-only. Reset: 3h. This register is bit significant. For each bit, 1=The corresponding port is available for software to use. 0=The port is not available for software to use. The maximum number of bits set to 1 shall not exceed SATAx00[NP] + 1, although the number of bits set in this register may be fewer than SATAx00[NP] + 1. At least one bit should be set to 1. This field is loaded by BIOS.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>Port 0 Implemented</td></tr> <tr> <td>[1]</td><td>Port 1 Implemented</td></tr> <tr> <td>[31:2]</td><td>Reserved</td></tr> </table>	Bit	Definition	[0]	Port 0 Implemented	[1]	Port 1 Implemented	[31:2]	Reserved
Bit	Definition								
[0]	Port 0 Implemented								
[1]	Port 1 Implemented								
[31:2]	Reserved								

SATAx10 AHCI Version (VS)

Bits	Description
31:16	MJR: Major Version Number. Read-only. Reset: 1. Indicates the major version is 1.
15:0	MNR: Minor Version Number. Read-only. Reset: 300h. Indicates the minor version is 10.

SATAx14 Command Completion Coalescing Control (CCC_CTL)

Bits	Description
31:16	<p>TV: Timeout Value. Read-write. Reset: 1. The timeout value is specified in 1 millisecond intervals. The timer accuracy shall be within 5%. hCccTimer is loaded with this timeout value. hCccTimer is only decremented when commands are outstanding on selected ports. The HBA will signal a CCC interrupt when hCccTimer has decremented to 0. hCccTimer is reset to the timeout value on the assertion of each CCC interrupt. A timeout value of 0 is reserved.</p>
15:8	<p>CC: Command Completions. Read-write. Reset: 1. Specifies the number of command completions that are necessary to cause a CCC interrupt. The HBA has an internal command completion counter, hCccComplete that is incremented by one each time a selected port has a command completion. When hCccComplete is equal to the command completions value, a CCC interrupt is signaled. The internal command completion counter is reset to 0 on the assertion of each CCC interrupt. 0=Disable CCC interrupts being generated based on the number of commands completed, i.e. CCC interrupts are only generated based on the timer in this case.</p>
7:3	<p>INT: CCC Interrupt. Read-only. Reset: 2h. Specifies the interrupt used by the Command Completion Coalescing (CCC) feature. This interrupt must be marked as unused in SATAx0C [Ports Implemented (PI)] by having the corresponding bit being set to 0. Thus, the CCC interrupt corresponds to the interrupt for an un-implemented port on the controller. When a CCC interrupt occurs, the corresponding bit in SATAx08 [Interrupt Status (IS)] shall be asserted to 1. This field also specifies the interrupt vector used for MSI.</p>

2:1	Reserved.
0	EN: CCC CTL Enable. Read-write. Reset: 0. 0=The Command Completion Coalescing (CCC) feature is disabled and no CCC interrupts are generated. 1=The CCC feature is enabled and CCC interrupts may be generated based on timeout or command completion conditions. Software shall only change the contents of the TV and CC fields in this register when this bit is cleared to 0. On transition of this bit from 0 to 1, any updated values for the TV and CC fields shall take effect.

SATAx18 Command Completion Coalescing Ports (CCC_PORTS)

Bits	Description
31:0	PRT: Ports. Read-write. Reset: 0. This register is bit significant. Each bit corresponds to a particular port, where bit 0 corresponds to port 0. If a bit is set to 1, the corresponding port is part of the command completion coalescing feature. If a bit is cleared to 0, the port is not part of the command completion coalescing feature. Bits set to 1 in this register must also have the corresponding bit set to 1 in the SATAx0C [Ports Implemented (PI)] . An updated value for this field shall take effect within one timer increment (1 millisecond).

SATAx1C Enclosure Management Location (EM_LOC)

Bits	Description
31:16	OFST: Offset. Value: 0000h. Specifies the offset of the message buffer in doublewords from the beginning of BAR5 defined by D11F0x24 .
15:0	SZ: Buffer Size. Value: 0000h. Specifies the size of the transmit message buffer area in doublewords. If both transmit and receive buffers are supported, then the transmit buffer begins at SATAx1C[OFST]*4 and the receive buffer directly follows it. If both transmit and receive buffers are supported, both buffers are of the size indicated in the Buffer Size field.

SATAx20 Enclosure Management Control (EM_CTL)

Bits	Description
31:28	Reserved.
27	ATTR_PM: Port Multiplier Support. Read-only. Reset: 0. 1=The HBA supports enclosure management messages for devices attached via a Port Multiplier. 0=The HBA does not. When cleared to 0, software should use the Serial ATA enclosure management bridge that is built into many Port Multipliers for enclosure services with these devices.
26	ATTR_ALHD: Activity LED Hardware Driven. Read-only. Reset: 0. 1=The HBA drives the activity LED for the LED message type in hardware and does not utilize software settings for this LED. The HBA does not begin transmitting the hardware based activity signal until after software has written CTL_TM to 1 after a reset condition.
25	ATTR_XMT: Transmit Only. Value: 0b. 1=The HBA only supports transmit messages and does not support receive messages. 0=The HBA supports transmit and receive messages.
24	ATTR_SMB: Single Message Buffer. Value: 0b. 1=The HBA has one message buffer that is shared for messages to transmit and messages received; Unsolicited receive messages are not supported and it is software's responsibility to manage access to this buffer. 0=There are separate receive and transmit buffers such that unsolicited messages could be supported.

23:20	Reserved.
19	SUPP_SGPIO: SGPIO Enclosure Management Messages. Value: 0b. 1=The HBA supports the SGPIO register interface message type.
18	SUPP_SES2: SES-2 Enclosure Management Messages. Read-only. Reset: 0. 1=The HBA supports the SES-2 message type.
17	SUPP_SAFTE: SAF-TE Enclosure Management Messages. Read-only. Reset: 0. 1=The HBA supports the SAF-TE message type.
16	SUPP_LED: LED Message Types. Read-only. Reset: 0. 1=The HBA supports the LED message type.
15:10	Reserved.
9	CTL_RST: Reset. Read-only. Reset: 0.
8	CTL_TM: Transmit Message. Read-only. Reset: 0.
7:1	Reserved.
0	STS_MR: Message Received. Read; write-1-to-clear. Reset: 0. The HBA sets this bit to a 1 when a message is completely received into the message buffer.

SATAx24 HBA Capabilities Extended (CAP2)

Bits	Description
31:6	Reserved.
5	DESO: DevSleep Entrance from Slumber Only. Read-only. Reset: 0. 1=The HBA shall ignore software directed entrance to DevSleep via SATAx1[9,1]8[ICC] unless [SATAx1[A,2]8IPM] = 6h. 0=The HBA may enter DevSleep from any link state (active, Partial, or Slumber).
4	SADM: Supports Aggressive Device Sleep Management. Read-only. Reset: 0. 1=The HBA supports hardware assertion of the DEVSLP signal after the idle timeout expires. 0=This function is not supported and software shall treat the PxDEVSLP.ADSE field as reserved.
3	SDS: Supports Device Sleep. Read-only. Reset: 0. 1=The HBA supports the Device Sleep feature. 0=DEVSLP is not supported and software shall not set SATAx1[9,1]8[ICC] to 8.
2:1	Reserved
0	BOH: BIOS/OS Handoff. Read-only. Reset: 0. 1=The HBA supports the BIOS/OS handoff mechanism and the HBA has implemented SATAx28 [BIOS/OS Handoff Control and Status (BOHC)] . 0=The HBA does not support the BIOS/OS handoff mechanism and SATAx28 [BIOS/OS Handoff Control and Status (BOHC)] is not implemented.

SATAx28 BIOS/OS Handoff Control and Status (BOHC)

Bits	Description
31:5	Reserved.
4	BB: BIOS Busy. Read-write. Reset: 0. This bit is used by the BIOS to indicate that it is busy cleaning up for ownership change.
3	OOC: OS Ownership Change. Read; write-1-to-clear. Reset: 0. This bit is set to 1 when the OOS bit transitions from 0 to 1.

2	SOOE: SMI on OS Ownership Change Enable. Read-write. Reset: 0. 1=Enables an SMI when the OOC bit has been set to 1.
1	OOS: OS Owned Semaphore. Read-write. Reset: 0. The system software sets this bit to request ownership of the HBA controller. Ownership is obtained when this bit reads 1 and the BOS bit reads 0.
0	BOS: BIOS Owned Semaphore. Read-write. Reset: 0. The BIOS sets this bit to establish ownership of the HBA controller. BIOS will clear this bit in response to a request for ownership of the HBA by system software via OOS.

3.26.3.3.2 Port Control Registers

The following registers configure the SATA ports and are implemented per port. Each port shall have the same register mapping. Port 0 starts at 100h. Port 1 starts at 180h. An algorithm to determine the offset is as follows: Port offset = 100h + (Asserted Bit Position in [SATAx0C \[Ports Implemented \(PI\)\]](#) * 80h).

SATAx1[8,0]0 Port 1,0 Command List Base Address (PxCLB)

Bits	Description
31:10	CLB[31:10]: Command List Base Address [31:10]. Read-write. Reset: 0. Specifies the lower 32 bits of the physical base address for the command list for this port. This base address is used by HBA to fetch commands to execute. The structure pointed to by this address range is 1K-bytes in length. This address must be 1K-byte aligned.
9:0	Reserved.

SATAx1[8,0]4 Port 1,0 Command List Base Upper Address (PxCLBU)

Bits	Description
31:0	CLBU: Command List Base Address Upper. Read-write. Reset: 0. Specifies the upper 32 bits of the physical base address for the command list for this port. If 64-bit addressing is not supported, this register reads 0.

SATAx1[8,0]8 Port 1,0 FIS Base Address (PxFB)

Bits	Description
31:8	FB[31:8]: FIS Base Address [31:8]. Read-write. Reset: 0. Specifies the lower 32 bits of the physical base address for the received FISes for this port. The structure pointed to by this address range is 256 bytes in length. This address must be 256-byte aligned.
7:0	Reserved.

SATAx1[8,0]C Port 1,0 FIS Base Address Upper (PxFBU)

Bits	Description
31:0	FBU: FIS Base Address Upper. Read-write. Reset: 0. Specifies the upper 32 bits of the physical base address for the received FISes for this port. If 64-bit addressing is not supported, this register reads 0.

SATAx1[9,1]0 Port 1,0 Interrupt Status (PxIS)

Bits	Description
31	CPDS: Cold Port Detect Status. Read; write-1-to-clear. Reset: 0.
30	TFES: Task File Error Status. Read; write-1-to-clear. Reset: 0. 1=The error bit at bit [0] of the status field in the received FIS is set to 1 when the status register is updated by the device.
29	HBFS: Host Bus Fatal Error Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has encountered a host bus error that it cannot recover from, such as a bad software pointer. In PCI, it indicates a target or master abort.
28	HBDS: Host Bus Data Error Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has encountered a data error (uncorrectable ECC / parity) when reading from or writing to system memory.
27	IFS: Interface Fatal Error Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has encountered an error on the Serial ATA interface, which caused the transfer to stop.
26	INFS: Interface Non-fatal Error Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has encountered an error on the Serial ATA interface and was able to continue operation.
25	Reserved.
24	OFS: Overflow Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has received more bytes from a device than what was specified in the PRD table for the command.
23	IPMS: Incorrect Port Multiplier Status. Read; write-1-to-clear. Reset: 0. 1=The HBA has received a FIS from a device whose Port Multiplier field did not match what was expected. The IPMS bit may be set during enumeration of devices on a Port Multiplier due to the normal Port Multiplier enumeration process. It is recommended that IPMS only be used after enumeration is complete on the Port Multiplier.
22	PRCS: PhyRdy Change Status. Read-only. Reset: 0. 1=The internal PhyRdy signal has changed state. This bit reflects the state of SATAx1[B,3]0[DIAG] . To clear this bit, software must program SATAx1[B,3]0[DIAG] to 0.
21:8	Reserved.
7	DMPS: Device Mechanical Presence Status. Read; write-1-to-clear. Reset: 0. 1=A mechanical presence switch attached to this port has been opened or closed, which may lead to a change in the connection state of the device. This bit is only valid if ((SATAx00[SMPS] ==1) && (SATAx1[9,1]8[MPSP] ==1)).
6	PCS: Port Connect Change Status. Read-only. Reset: 0. 0=No change in Current Connect Status. 1=Change in Current Connect Status. This bit reflects the state of SATAx1[B,3]0[DIAG[10]] . This bit is only cleared when SATAx1[B,3]0[DIAG] is cleared.
5	DPS: Descriptor Processed. Read; write-1-to-clear. Reset: 0. 1=A Physical Region Descriptor (PRD) with the I bit set has transferred all of its data.
4	UFS: Unknown FIS Interrupt. Read-only. Reset: 0. 1=An unknown FIS was received with the I bit set and has been copied into system memory. This bit is cleared to 0 by software clearing the SATAx1[B,3]0[DIAG] bit to 0. This bit does not directly reflect the SATAx1[B,3]0[DIAG] bit. SATAx1[B,3]0[DIAG] is set immediately when an unknown FIS is detected, whereas this bit is set when that FIS is posted to memory. Software should wait to act on an unknown FIS until this bit is set to 1, or the two bits may become out-of- sync.
3	SDBS: Set Device Bits Interrupt. Read; write-1-to-clear. Reset: 0. 1=A Set Device Bits FIS has been received with the I bit set and has been copied into system memory.

2	DSS: DMA Setup FIS Interrupt. Read-write. Reset: 0. 1=A DMA Setup FIS has been received with the I bit set and has been copied into system memory.
1	PSS: PIO Setup FIS Interrupt. Read; write-1-to-clear. Reset: 0. 1=A PIO Setup FIS has been received with the I bit set, and it has been copied into system memory, and the data related to that FIS has been transferred. This bit shall be set even if the data transfer resulted in an error.
0	DHRS: Device to Host Register FIS Interrupt. Read; write-1-to-clear. Reset: 0. 1=A D2H Register FIS has been received with the I bit set, and has been copied into system memory.

SATAx1[9,1]4 Port 1,0 Interrupt Enable (PxIE)

Bits	Description
31	CPDE: Cold Presence Detect Enable. Read-only. Reset: 0.
30	TFEE: Task File Error Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[TFES]==1)).
29	HBFE: Host Bus Fatal Error Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[HBFS]==1)).
28	HBDE: Host Bus Data Error Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && SATAx1[9,1]0[HBDS]==1)).
27	IFE: Interface Fatal Error Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[IFS]==1)).
26	INFE: Interface Non-fatal Error Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[INFS]==1)).
25	Reserved.
24	OFE: Overflow Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[OFS]==1)).
23	IPME: Incorrect Port Multiplier Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[IPMS]==1)).
22	PRCE: PhyRdy Change Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[PRCS]==1)).
21:8	Reserved.
7	DMPE: Device Mechanical Presence Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[DMPS]==1)). For systems that do not support a mechanical presence switch, this bit is read-only and will return a 0.
6	PCE: Port Change Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[PCS]==1)).
5	DPE: Descriptor Processed Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[DPS]==1)).
4	UFE: Unknown FIS Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[UFS]==1)).
3	SDBE: Set Device Bits FIS Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[SDBS]==1)).
2	DSE: DMA Setup FIS Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[DSS]==1)).

1	PSE: PIO Setup FIS Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[PSS]==1)).
0	DHRE: Device to Host Register FIS Interrupt Enable. Read-write. Reset: 0. 1=The HBA generates an interrupt if ((SATAx04[IE]==1) && (SATAx1[9,1]0[DHRS]==1)).

SATAx1[9,1]8 Port 1,0 Command and Status (PxCMD)

Bits	Description																		
31:28	ICC: Interface Communication Control. Read-write. Reset: 0. This field is used to control power management states of the interface. If the Link layer is currently in the L_IDLE state, writing to this field shall cause the HBA to initiate a transition to the interface power management state requested. If the Link layer is not currently in the L_IDLE state, writing to this field shall have no effect.																		
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> <tr> <td>8h</td><td>DevSleep: This shall cause the HBA to assert the DEVSLP signal associated with the port; the HBA shall ignore the Device Sleep Idle Timeout value specified by PxDEVSLP.DITO. Software shall only request DevSleep when the interface is in an idle state (i.e. PxCI is cleared to 0h and PxSACT are cleared to 0h); if CAP2.SDS is cleared to '0' or if the interface is not idle at the time the register is written, then the HBA shall not assert the DEVSLP signal and the interface remains in its current state. If CAPS.SDS is set to '1', CAP2.DESO is set to '1', and PxSSTS.IPM is not set to '6h', then the HBA shall not assert the DEVSLP signal and the interface shall remain in its current state. Additionally, the HBA shall not assert the DEVSLP signal until PHYRDY has been achieved (after a previous de-assertion).</td></tr> <tr> <td>7h</td><td>Reserved</td></tr> <tr> <td>6h</td><td>Slumber: This shall cause the HBA to request a transition of the interface to the Slumber state. The SATA device may reject the request and the interface shall remain in its current state.</td></tr> <tr> <td>5h-3h</td><td>Reserved</td></tr> <tr> <td>2h</td><td>Partial: This shall cause the HBA to request a transition of the interface to the Partial state. The SATA device may reject the request and the interface shall remain in its current state.</td></tr> <tr> <td>1h</td><td>Active: This shall cause the HBA to request a transition of the interface into the active state.</td></tr> <tr> <td>0h</td><td>No-Op, Idle: When software reads this value, it indicates the HBA is ready to accept a new interface control command, although the transition to the previously selected state may not have occurred yet.</td></tr> </table> <p>When system software writes a non-reserved value other than No-Op (0h), the HBA shall perform the action and update this field back to Idle (0h). If software writes to this field to change the state to a state the link is already in (i.e. interface is in the active state and a request is made to go to the active state), the HBA shall take no action and return this field to Idle. If the interface is in a low power state and software wants to transition to a different low power state, software must first bring the link to active and then initiate the transition to the desired low power state with the exception of DEVSLP. The transition to DevSleep may occur from any other state if SATAx24[DESO]==0. If SATAx24[DESO]==1, then DevSleep may only be transitioned to if the link is in Slumber.</p>	Bits	Definition	Fh-9h	Reserved	8h	DevSleep: This shall cause the HBA to assert the DEVSLP signal associated with the port; the HBA shall ignore the Device Sleep Idle Timeout value specified by PxDEVSLP.DITO. Software shall only request DevSleep when the interface is in an idle state (i.e. PxCI is cleared to 0h and PxSACT are cleared to 0h); if CAP2.SDS is cleared to '0' or if the interface is not idle at the time the register is written, then the HBA shall not assert the DEVSLP signal and the interface remains in its current state. If CAPS.SDS is set to '1', CAP2.DESO is set to '1', and PxSSTS.IPM is not set to '6h', then the HBA shall not assert the DEVSLP signal and the interface shall remain in its current state. Additionally, the HBA shall not assert the DEVSLP signal until PHYRDY has been achieved (after a previous de-assertion).	7h	Reserved	6h	Slumber: This shall cause the HBA to request a transition of the interface to the Slumber state. The SATA device may reject the request and the interface shall remain in its current state.	5h-3h	Reserved	2h	Partial: This shall cause the HBA to request a transition of the interface to the Partial state. The SATA device may reject the request and the interface shall remain in its current state.	1h	Active: This shall cause the HBA to request a transition of the interface into the active state.	0h	No-Op, Idle: When software reads this value, it indicates the HBA is ready to accept a new interface control command, although the transition to the previously selected state may not have occurred yet.
Bits	Definition																		
Fh-9h	Reserved																		
8h	DevSleep: This shall cause the HBA to assert the DEVSLP signal associated with the port; the HBA shall ignore the Device Sleep Idle Timeout value specified by PxDEVSLP.DITO. Software shall only request DevSleep when the interface is in an idle state (i.e. PxCI is cleared to 0h and PxSACT are cleared to 0h); if CAP2.SDS is cleared to '0' or if the interface is not idle at the time the register is written, then the HBA shall not assert the DEVSLP signal and the interface remains in its current state. If CAPS.SDS is set to '1', CAP2.DESO is set to '1', and PxSSTS.IPM is not set to '6h', then the HBA shall not assert the DEVSLP signal and the interface shall remain in its current state. Additionally, the HBA shall not assert the DEVSLP signal until PHYRDY has been achieved (after a previous de-assertion).																		
7h	Reserved																		
6h	Slumber: This shall cause the HBA to request a transition of the interface to the Slumber state. The SATA device may reject the request and the interface shall remain in its current state.																		
5h-3h	Reserved																		
2h	Partial: This shall cause the HBA to request a transition of the interface to the Partial state. The SATA device may reject the request and the interface shall remain in its current state.																		
1h	Active: This shall cause the HBA to request a transition of the interface into the active state.																		
0h	No-Op, Idle: When software reads this value, it indicates the HBA is ready to accept a new interface control command, although the transition to the previously selected state may not have occurred yet.																		

27	ASP: Aggressive Slumber/Partial. Read-write. Reset: 0. When set to 1, and ALPE==1, the HBA shall aggressively enter the Slumber state when it clears SATAx1[B,3]8 and SATAx1[B,3]4 is cleared or when it clears the SATAx1[B,3]4 register and SATAx1[B,3]8 is cleared. When cleared, and ALPE==1, the HBA shall aggressively enter the Partial state when it clears the SATAx1[B,3]8 register and the SATAx1[B,3]4 register is cleared or when it clears the SATAx1[B,3]4 register and SATAx1[B,3]8 is cleared. See SATAx00[SALP] .
26	ALPE: Aggressive Link Power Management Enable. Read-write. Reset: 0. 1=The HBA shall aggressively enter a lower link power state (Partial or Slumber) based upon the setting of the ASP bit. See SATAx00[SALP] .
25	DLAE: Drive LED on ATAPI Enable. Read-write. Reset: 0. 1=The HBA shall drive the LED pin active for commands regardless of the state of bit ATAPI. 0=The HBA shall only drive the LED pin active for commands if bit ATAPI==0.
24	ATAPI: Device is ATAPI. Read-write. Reset: 0. 1=The connected device is an ATAPI device. This bit is used by the HBA to control whether or not to generate the desktop LED when commands are active.
23	Reserved.
22	FBSCP: FIS-based Switching Capable Port. Read-only. Reset: 1. 1=Indicates that this port supports Port Multiplier FIS-based switching.
21	ESP: External SATA Port. Read-only. Reset: 0. 0=Indicates that this port's signal connector is not externally accessible on a signal only connector. ESP is mutually exclusive with the HPCP bit in this register.
20	CPD: Cold Presence Detection. Read-only. Reset: 0. 0=The platform does not support cold presence detection on this port.
19	MPSP: Mechanical Presence Switch Attached to Port. Read-only. Reset: 0. 0=The platform does not support a mechanical presence switch attached to this port.
18	HPCP: Hot Plug Capable Port. Read-only. Reset: 0. 0=Indicates that this port's signal and power connectors are not externally accessible via a joint signal and power connector.
17	PMA: Port Multiplier Attached. Read-write. Reset: 0. 1=A Port Multiplier is attached to the HBA for this port. 0=A Port Multiplier is not attached to the HBA for this port. Software is responsible for detecting whether a Port Multiplier is present; hardware does not auto-detect the presence of a Port Multiplier.
16	CPS: Cold Presence State. Read-only. Reset: 0. The CPS bit reports whether a device is currently detected on this port via cold presence detection. 1=The HBA detects via cold presence that a device is attached to this port. 0=The HBA detects via cold presence that there is no device attached to this port.
15	CR: Command List Running. Read-only. Reset: 0. 1=The command list DMA engine for the port is running.
14	FR: FIS Receive Running. Read-only. Reset: 0. 1=The FIS Receive DMA engine for the port is running.
13	MPSS: Mechanical Presence Switch State. Read-only. Reset: 1. This bit reports the state of a mechanical presence switch attached to this port. If SATAx00[SMPS] ==1 and the mechanical presence switch is closed then this bit is cleared to 0. If SATAx00[SMPS] ==1 and the mechanical presence switch is open then this bit is set to 1. If SATAx00[SMPS] ==0 then this bit is cleared to 0. Software should only use this bit if ((SATAx00[SMPS] ==1) && (SATAx1[9,1]8[MPSP] ==1)).

12:8	CCS: Current Command Slot. Read-only; updated-by-hardware. Reset: 0. This field is valid if SATAx1[9,1]8[ST]==1 and shall be set to the command slot value of the command that is currently being issued by the HBA. When SATAx1[9,1]8[ST] transitions from 1 to 0, this field shall be reset to 0. After SATAx1[9,1]8[ST] transitions from 0 to 1, the highest priority slot to issue from next is command slot 0. After the first command has been issued, the highest priority slot to issue from next is CCS+1. For example, after the HBA has issued its first command, if CCS==0 and SATAx1[B,3]8==3 , the next command that is issued is from command slot 1.
7:5	Reserved.
4	FRE: FIS Receive Enable. Read-write. Reset: 0. 1=The HBA may post the received FISes into the FIS receive area pointed to by SATAx1[8,0]8 [Port 1,0 FIS Base Address (PxFB)] (and SATAx1[8,0]C [Port 1,0 FIS Base Address Upper (PxFBU)] for 64-bit HBAs). 0=Received FISes are not accepted by the HBA, except for the first D2H register FIS after the initialization sequence, and no FISes are posted to the FIS receive area. System software must not set this bit until SATAx1[8,0]8 (and SATAx1[8,0]C for 64-bit) have been programmed with a valid pointer to the FIS receive area. If software wishes to move the base, this bit must first be cleared, and software must wait for the FR bit in this register to be cleared.
3	CLO: Command List Override. Read; write-1-only; cleared-by-hardware. Reset: 0. Setting this bit to 1 causes SATAx1[A,2]0[STS[7], STS[3]] to be cleared to 0. This allows a software reset to be transmitted to the device regardless of whether the BSY and DRQ bits are still set in the SATAx1[A,2]0[STS] register. The HBA sets this bit to 0 when SATAx1[A,2]0[STS[7], STS[3]] have been cleared to 0. This bit shall only be set to 1 immediately prior to setting SATAx1[9,1]8[ST] to 1 from a previous value of 0. Setting this bit to 1 at any other time is not supported and results in indeterminate behavior. Software must wait for CLO to be cleared to 0 before setting SATAx1[9,1]8[ST] to 1.
2	POD: Power On Device. Read-only. Reset: 1. 1=HBAs does not support cold presence detect and the HBA sets the state of a pin on the HBA to 1 so that it may be used to provide power to a cold-presence detectable port.
1	SUD: Spin-Up Device. Read-only. Reset: 1. 1=HBAs does not support staggered spin-up.
0	ST: Start. Read-write. Reset: 0. 1=The HBA may process the command list. 0=The HBA may not process the command list. Whenever this bit is changed from 0 to 1, the HBA starts processing the command list at entry 0. Whenever this bit is changed from a 1 to a 0, SATAx1[B,3]8 is cleared by the HBA upon the HBA putting the controller into an idle state. Software should only set this bit after SATAx1[9,1]8[FRE] has been set to 1.

SATAx1[A,2]0 Port 1,0 Task File Data (PxTFD)

Bits	Description												
31:16	Reserved.												
15:8	ERR: Error. Read-only. Reset: 0. Contains the latest copy of the task file error register.												
7:0	STS: Status. Read-only; updated-by-hardware. Reset: 7Fh. Contains the latest copy of the task file status register. Fields of note in this register that affect AHCI hardware operation are: <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[7]</td><td>BSY. 1=Indicates the interface is busy</td></tr> <tr> <td>[6:4]</td><td>CS. Command specific</td></tr> <tr> <td>[3]</td><td>DRQ. 1=Indicates a data transfer is requested</td></tr> <tr> <td>[2:1]</td><td>CS. Command specific</td></tr> <tr> <td>[0]</td><td>ERR. 1=Indicates an error during the transfer</td></tr> </table>	Bit	Definition	[7]	BSY. 1=Indicates the interface is busy	[6:4]	CS. Command specific	[3]	DRQ. 1=Indicates a data transfer is requested	[2:1]	CS. Command specific	[0]	ERR. 1=Indicates an error during the transfer
Bit	Definition												
[7]	BSY. 1=Indicates the interface is busy												
[6:4]	CS. Command specific												
[3]	DRQ. 1=Indicates a data transfer is requested												
[2:1]	CS. Command specific												
[0]	ERR. 1=Indicates an error during the transfer												

SATAx1[A,2]4 Port 1,0 Signature (PxSIG)

Bits	Description										
31:0	<p>SIG: Signature. Read-write. Reset: FFFF_FFFFh. Contains the signature received from a device on the first D2H Register FIS. The bit order is as following:</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[31:24]</td><td>LBA High Register</td></tr> <tr> <td>[23:16]</td><td>LBA Mid Register</td></tr> <tr> <td>[15:08]</td><td>LBA Low Register</td></tr> <tr> <td>[07:00]</td><td>Sector Count Register</td></tr> </table> <p>The register is updated once after each reset sequence.</p>	Bit	Definition	[31:24]	LBA High Register	[23:16]	LBA Mid Register	[15:08]	LBA Low Register	[07:00]	Sector Count Register
Bit	Definition										
[31:24]	LBA High Register										
[23:16]	LBA Mid Register										
[15:08]	LBA Low Register										
[07:00]	Sector Count Register										

SATAx1[A,2]8 Port 1,0 Serial ATA Status (PxSSTS)

Bits	Description																		
31:12	Reserved.																		
11:8	<p>IPM: Interface Power Management. Read-only; updated-by-hardware. Reset: 0. Indicates the current interface state.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Device not present or communication not established</td></tr> <tr> <td>1h</td><td>Interface in Active state</td></tr> <tr> <td>2h</td><td>Interface in Partial power management state</td></tr> <tr> <td>5h-3h</td><td>Reserved</td></tr> <tr> <td>6h</td><td>Interface in Slumber power management state</td></tr> <tr> <td>7h</td><td>Reserved</td></tr> <tr> <td>8h</td><td>Interface in DevSleep power management state</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>	Bits	Definition	0h	Device not present or communication not established	1h	Interface in Active state	2h	Interface in Partial power management state	5h-3h	Reserved	6h	Interface in Slumber power management state	7h	Reserved	8h	Interface in DevSleep power management state	Fh-9h	Reserved
Bits	Definition																		
0h	Device not present or communication not established																		
1h	Interface in Active state																		
2h	Interface in Partial power management state																		
5h-3h	Reserved																		
6h	Interface in Slumber power management state																		
7h	Reserved																		
8h	Interface in DevSleep power management state																		
Fh-9h	Reserved																		
7:4	<p>SPD: Current Interface Speed. Read-only; updated-by-hardware. Reset: 0. Indicates the negotiated interface communication speed.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Device not present or communication not established</td></tr> <tr> <td>1h</td><td>Generation 1 communication rate negotiated</td></tr> <tr> <td>2h</td><td>Generation 2 communication rate negotiated</td></tr> <tr> <td>3h</td><td>Generation 3 communication rate negotiated</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Definition	0h	Device not present or communication not established	1h	Generation 1 communication rate negotiated	2h	Generation 2 communication rate negotiated	3h	Generation 3 communication rate negotiated	Fh-4h	Reserved						
Bits	Definition																		
0h	Device not present or communication not established																		
1h	Generation 1 communication rate negotiated																		
2h	Generation 2 communication rate negotiated																		
3h	Generation 3 communication rate negotiated																		
Fh-4h	Reserved																		
3:0	<p>DET: Device Detection. Read-only; updated-by-hardware. Reset: 0. Indicates the interface device detection and PHY state.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>No device detected and PHY communication not established</td></tr> <tr> <td>1h</td><td>Device presence detected but PHY communication not established</td></tr> <tr> <td>2h</td><td>Reserved.</td></tr> <tr> <td>3h</td><td>Device presence detected and PHY communication established</td></tr> <tr> <td>4h</td><td>PHY in offline mode as a result of the interface being disabled or running in a BIST loopback mode</td></tr> <tr> <td>Fh-5h</td><td>Reserved</td></tr> </table>	Bits	Definition	0h	No device detected and PHY communication not established	1h	Device presence detected but PHY communication not established	2h	Reserved.	3h	Device presence detected and PHY communication established	4h	PHY in offline mode as a result of the interface being disabled or running in a BIST loopback mode	Fh-5h	Reserved				
Bits	Definition																		
0h	No device detected and PHY communication not established																		
1h	Device presence detected but PHY communication not established																		
2h	Reserved.																		
3h	Device presence detected and PHY communication established																		
4h	PHY in offline mode as a result of the interface being disabled or running in a BIST loopback mode																		
Fh-5h	Reserved																		

SATAx1[A,2]C Port 1,0 Serial ATA Control (PxSCTL)

Bits	Description																				
31:20	Reserved.																				
19:16	PMP: Port Multiplier Port. Read-only. Reset: 0. This field is not used by AHCI.																				
15:12	SPM: Select Power Management. Read-only. Reset: 0. This field is not used by AHCI.																				
11:8	<p>IPM: Interface Power Management Transitions Allowed. Read-write. Reset: 0. Indicates which power states the HBA is allowed to transition to. If an interface power management state is disabled, the HBA is not allowed to initiate that state and the HBA must respond with power management denial to any request from the device to enter that state.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>No interface restrictions</td></tr> <tr> <td>1h</td><td>Disable transitions to the Partial state.</td></tr> <tr> <td>2h</td><td>Disable transitions to the Slumber state.</td></tr> <tr> <td>3h</td><td>Disable transitions to both Partial and Slumber states.</td></tr> <tr> <td>4h</td><td>Disable transitions to the DevSleep power management state.</td></tr> <tr> <td>5h</td><td>Disable transitions to the Partial and DevSleep power management states.</td></tr> <tr> <td>6h</td><td>Disable transitions to the Slumber and DevSleep power management states.</td></tr> <tr> <td>7h</td><td>Disable transitions to the Partial, Slumber and DevSleep power management states.</td></tr> <tr> <td>Fh-8h</td><td>Reserved</td></tr> </table>	Bits	Definition	0h	No interface restrictions	1h	Disable transitions to the Partial state.	2h	Disable transitions to the Slumber state.	3h	Disable transitions to both Partial and Slumber states.	4h	Disable transitions to the DevSleep power management state.	5h	Disable transitions to the Partial and DevSleep power management states.	6h	Disable transitions to the Slumber and DevSleep power management states.	7h	Disable transitions to the Partial, Slumber and DevSleep power management states.	Fh-8h	Reserved
Bits	Definition																				
0h	No interface restrictions																				
1h	Disable transitions to the Partial state.																				
2h	Disable transitions to the Slumber state.																				
3h	Disable transitions to both Partial and Slumber states.																				
4h	Disable transitions to the DevSleep power management state.																				
5h	Disable transitions to the Partial and DevSleep power management states.																				
6h	Disable transitions to the Slumber and DevSleep power management states.																				
7h	Disable transitions to the Partial, Slumber and DevSleep power management states.																				
Fh-8h	Reserved																				
7:4	<p>SPD: Speed Allowed. Read-write. Reset: 0. Indicates the highest allowable speed of the interface.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>No speed negotiation restrictions</td></tr> <tr> <td>1h</td><td>Limit speed negotiation to Generation 1 communication rate</td></tr> <tr> <td>2h</td><td>Limit speed negotiation to a rate not greater than Generation 2 communication rate</td></tr> <tr> <td>3h</td><td>Limit speed negotiation to a rate not greater than Generation 3 communication rate</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>	Bits	Definition	0h	No speed negotiation restrictions	1h	Limit speed negotiation to Generation 1 communication rate	2h	Limit speed negotiation to a rate not greater than Generation 2 communication rate	3h	Limit speed negotiation to a rate not greater than Generation 3 communication rate	Fh-4h	Reserved								
Bits	Definition																				
0h	No speed negotiation restrictions																				
1h	Limit speed negotiation to Generation 1 communication rate																				
2h	Limit speed negotiation to a rate not greater than Generation 2 communication rate																				
3h	Limit speed negotiation to a rate not greater than Generation 3 communication rate																				
Fh-4h	Reserved																				
3:0	<p>DET: Device Detection Initialization. Read-write. Reset: 0. Controls the HBA's device detection and interface initialization.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>No device detection or initialization action requested</td></tr> <tr> <td>1h</td><td>Perform interface communication initialization sequence to establish communication. This is functionally equivalent to a hard reset and results in the interface being reset and communications re-initialized. While this field is 1h, COMRESET is transmitted on the interface. Software should leave the DET field set to 1h for a minimum of 1 millisecond to ensure that a COMRESET is sent on the interface.</td></tr> <tr> <td>3h-2h</td><td>Reserved</td></tr> <tr> <td>4h</td><td>Disable the Serial ATA interface and put PHY in off-line mode</td></tr> <tr> <td>Fh-5h</td><td>Reserved</td></tr> </table> <p>This field may only be modified when SATAx1[9,1]8[ST]==0. Changing this field while SATAx1[9,1]8[ST]==1 results in undefined behavior. When SATAx1[9,1]8[ST]==1, this field should have a value of 0.</p>	Bits	Definition	0h	No device detection or initialization action requested	1h	Perform interface communication initialization sequence to establish communication. This is functionally equivalent to a hard reset and results in the interface being reset and communications re-initialized. While this field is 1h, COMRESET is transmitted on the interface. Software should leave the DET field set to 1h for a minimum of 1 millisecond to ensure that a COMRESET is sent on the interface.	3h-2h	Reserved	4h	Disable the Serial ATA interface and put PHY in off-line mode	Fh-5h	Reserved								
Bits	Definition																				
0h	No device detection or initialization action requested																				
1h	Perform interface communication initialization sequence to establish communication. This is functionally equivalent to a hard reset and results in the interface being reset and communications re-initialized. While this field is 1h, COMRESET is transmitted on the interface. Software should leave the DET field set to 1h for a minimum of 1 millisecond to ensure that a COMRESET is sent on the interface.																				
3h-2h	Reserved																				
4h	Disable the Serial ATA interface and put PHY in off-line mode																				
Fh-5h	Reserved																				

SATAx1[B,3]0 Port 1,0 Serial ATA Error(PxSERR)

Bits	Description
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31:16	DIAG: Diagnostics. Read; write-1-to-clear. Reset: 0. Contains diagnostic error information for use by diagnostic software in validating correct operation or isolating failure modes:
<u>Bit</u>	<u>Definition</u>
[15:11]	Reserved
[10]	Exchanged (X). Indicates a COMINIT signal was received. This bit is reflected in SATAx1[9,1]0[PCS] .
[9]	Unknown FIS Type (F). Indicates that one or more FISs were received by the Transport layer with good CRC, but had a type field that was not recognized/known.
[8]	Transport state transition error (T). Indicates that an error has occurred in the transition from one state to another within the Transport layer since the last time this bit was cleared. This bit is always 0 in the current implementation.
[7]	Link Sequence Error (S). Indicates that one or more Link state machine error conditions was encountered. The Link Layer state machine defines the conditions under which the link layer detects an erroneous transition. This bit is always 0 in the current implementation.
[6]	Handshake Error (H). Indicates that one or more R_ERR handshake responses were received in response to frame transmission. Such errors may be the result of a CRC error detected by the recipient, a disparity or 8b/10b decoding error, or other error condition leading to a negative handshake on a transmitted frame.
[5]	CRC Error (C). Indicates that one or more CRC errors occurred with the Link Layer.
[4]	Disparity Error (D). This field is not used by AHCI. This bit is always 0 in the current implementation.
[3]	10B to 8B Decode Error (B). Indicates that one or more 10B to 8B decoding errors has occurred.
[2]	Comm Wake (W). Indicates that a Comm Wake signal was detected by the PHY.
[1]	Phy Internal Error (I). Indicates that the PHY detected some internal error. This bit is always 0 in the current implementation.
[0]	PhyRdy Change (N). Indicates that the PhyRdy signal changed state. This bit is reflected in the SATAx1[9,1]0[PRCS] bit.

15:0	Err: Error. Read; write-1-to-clear. Reset: 0. Contains error information for use by host software in determining the appropriate response to the error condition.
<u>Bit</u>	<u>Definition</u>
[15:12]	Reserved.
[11]	Internal Error (E). The host bus adapter experienced an internal error that caused the operation to fail and may have put the host bus adapter into an error state. The internal error may include a master or target abort when attempting to access system memory, an elasticity buffer overflow, a primitive mis-alignment, a synchronization FIFO overflow, and other internal error conditions. Typically, when an internal error occurs, a non-fatal or fatal status bit in SATAx1[9,1]0 register will also be set to give software guidance on the recovery mechanism required.
[10]	Protocol Error (P). A violation of the Serial ATA protocol was detected.
[9]	Persistent Communication or Data Integrity Error (C). A communication error that was not recovered occurred and is expected to be persistent. Persistent communication errors may arise from faulty interconnect with the device, from a device that has been removed or has failed, or a number of other causes.
[8]	Transient Data Integrity Error (T). A data integrity error occurred that was not recovered by the interface. This bit is set upon any error when a Data FIS is received, including reception FIFO overflow, CRC error, or 10b/8b decoding error.
[7:2]	Reserved.
[1]	Recovered Communications Error (M). Communications between the device and host was temporarily lost but was re-established. This can arise from a device temporarily being removed, from a temporary loss of PHY synchronization, or from other causes and may be derived from the PhyNRdy signal between the PHY and Link layers.
[0]	Recovered Data Integrity Error (I). A data integrity error occurred that was recovered by the interface through a retry operation or other recovery action. This bit is set upon any error when a Data FIS is received, including reception FIFO overflow, CRC error, or 10b/8b decoding error.

SATAx1[B,3]4 Port 1,0 Serial ATA Active (PxSACT)

Bits	Description
31:0	DS: Device Status. Read; write-1-only; cleared-by-hardware. Reset: 0. This field is bit significant. Each bit corresponds to the TAG and command slot of a native queued command, where bit 0 corresponds to TAG 0 and command slot 0. This field is set by software prior to issuing a native queued command for a particular command slot. Prior to writing SATAx1[B,3]8 TAG to 1, software sets DS TAG to 1 to indicate that a command with that TAG is outstanding. The device clears bits in this field by sending a Set Device Bits FIS to the host. The HBA clears bits in this field that are set to 1 in the SActive field of the Set Device Bits FIS. The HBA only clears bits that correspond to native queued commands that have completed successfully. Software should only write to this field when SATAx1[9,1]8[ST] ==1. This field is cleared when SATAx1[9,1]8[ST] is written from 1 to 0 by software. This field is not cleared by a COMRESET or a software reset.

SATAx1[B,3]8 Port 1,0 Command Issue (PxCI)

Bits	Description
31:0	CI: Commands Issued. Read; write-1-only; cleared-by-hardware. Reset: 0. This field is bit significant. Each bit corresponds to a command slot, where bit 0 corresponds to command slot 0. This field is set by software to indicate to the HBA that a command has been built in system memory for a command slot and may be sent to the device. When the HBA receives a FIS which clears the BSY, DRQ, and ERR bits for the command, it clears the corresponding bit in this register for that command slot. Bits in this field shall only be set to 1 by software when SATAx1[9,1]8[ST] is set to 1. This field is also cleared when SATAx1[9,1]8[ST] is written from 1 to 0 by software.

SATAx1[B,3]C Port 1,0 SNotification (PxSNTF)

Bits	Description
31:16	Reserved.
15:0	PMN: PM Notify. Read; write-1-to-clear. Reset: 0. This field is bit significant. Each bit corresponds to a Port Multiplier (PM) port number, where bit 0 corresponds to PM port 0 and bit 15 corresponds to PM port 15. This field indicates whether a particular device with the corresponding PM Port number issued a Set Device Bits FIS to the host with the Notification bit set. Individual bits are cleared by software writing 1 to the corresponding bit positions. This field is reset to default on a HBA Reset, but it is not reset by COMRESET or software reset.

SATAx1[C,4]0 Port 1,0 FIS-based Switching Control (PxFBS)

Bits	Description
31:20	Reserved.
19:16	DWE: Device With Error. Read-only; updated-by-hardware. Reset: 0. Set by hardware to the value of the Port Multiplier port number of the device that experienced a fatal error condition. This field is only valid when SATAx1[C,4]0[SDE] ==1.
15:12	ADO: Active Device Optimization. Read-only. . Reset: 2h. This register exposes the number of active devices that the FIS-based switching implementation has been optimized for. When there are more devices active than indicated in this field, throughput of concurrent traffic may degrade. For optimal performance, software should limit the number of active devices based on this value. The minimum value for this field shall be 2h, indicating that at least two devices may be active with high performance maintained.
11:8	DEV: Device To Issue. Read-write. Reset: 0. Set by software to the Port Multiplier port value of the next command to issue. This field enables hardware to know the port the command is to be issued to without fetching the command header. Software shall not issue commands to multiple Port Multiplier ports on the same write of SATAx1[B,3]8 register.
7:3	Reserved.

2	SDE: Single Device Error. Read-only. Reset: 0. 1=When a fatal error condition has occurred, hardware believes the error is localized to one device such that software's first error recovery step should be to utilize the SATAx1[C,4]0[DEC] functionality. 0=When a fatal error condition has occurred, the error applies to the entire port and to clear the error SATAx1[9,1]8[ST] shall be cleared to 0 by software. This bit is cleared on SATAx1[C,4]0[DEC] being set to 1 or on SATAx1[9,1]8[ST] being cleared to 0.
1	DEC: Device Error Clear. Read; write-1-only; cleared-by-hardware. Reset: 0. When set to 1 by software, the HBA shall clear the device-specific error condition and the HBA shall flush any commands outstanding for the device that experienced the error, including clearing SATAx1[B,3]8 and SATAx1[B,3]4 bits for that device to 0. When hardware has completed error recovery actions, hardware shall clear the bit to 0. Software shall only set this bit to 1 if ((SATAx1[C,4]0[EN] ==1) && (SATAx1[C,4]0[SDE] ==1)).
0	EN: Enable. Read-write. Reset: 0. 1=A Port Multiplier is attached and the HBA shall use FIS-based switching to communicate with it. 0=FIS-based switching is not being used. Software shall only change the value of this bit when SATAx1[9,1]8[ST] ==0.

SATAx1[C,4]4 Port 1,0 Device Sleep (PxDEVSLP)

Bits	Description			
31:29	Reserved.			
28:25	DM: DITO Multiplier. Read-only. Reset: 0. 0's based value that specifies the DITO multiplier that the HBA applies to the specified DITO value, effectively extending the range of DITO from 1 ms to 16383 ms. The HBA computes the total idle timeout as a product of DM and DITO (i.e. DITOactual = DITO * DM).			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	multiply 1	Eh-2h	multiply <DM+1>
	1h	multiply 2	Fh	multiply 16
24:15	DITO: Device Sleep Idle Timeout. IF ((SATAx24[SDS]==0) (SATAx24[SADM]==0)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. This field specifies the amount of the time (in approximate 1 ms granularity) that the HBA shall wait before driving the DEVSLP signal. Hardware reloads its port specific Device Sleep timer with this value each time the port transitions out of the DEVSLP state. For example: from DevSleep to Active or SATAx1[C,4]4[ADSE] transitions from 0 to 1. Software shall only set this value when SATAx1[9,1]8[ST]==0 and SATAx1[C,4]4[ADSE]==0.			
14:10	MDAT: Minimum Device Sleep Assertion Time. IF (SATAx24[SDS]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. This field specifies the minimum amount of time (in 1 ms granularity) that the HBA must assert the DEVSLP signal before it may be de-asserted. The nominal value is 10 ms and the minimum is 1 ms depending on device identification information. Software shall only set this value when SATAx1[9,1]8[ST]==0, SATAx1[C,4]4[ADSE]==0 and prior to setting SATAx1[9,1]8[ICC] to 8h.			
9:2	DETO: Device Sleep Exit Timeout. IF (SATAx24[SDS]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. This field specifies the maximum duration (in approximate 1 ms granularity) from DEVSLP de-assertion until the device is ready to accept OOB. The nominal value is 20 ms while the max value is 255 ms depending on device identification information. Software shall only set this value when SATAx1[9,1]8[ST]==0, SATAx1[C,4]4[ADSE]==0 and prior to setting SATAx1[9,1]8[ICC] to 8h.			

1	DSP: Device Sleep Present. Read-write. Reset: 0. 1=The platform supports Device Sleep on this port. 0=The platform does not support Device Sleep on this port. This bit may only be set to 1 if SATAx24[SDS]==1 . DSP is mutually exclusive with the SATAx1[9,1]8[HPCP] bit and SATAx1[9,1]8[ESP] bit.
0	ADSE: Aggressive Device Sleep Enable. IF ((SATAx24[SADM]==1) && (SATAx24[SDS]==1)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0. 0=The HBA does not enter DevSleep unless software directed via SATAx1[9,1]8[ICC] . 1=The HBA shall assert the DEVSLP signal after the port has been idle (SATAx1[B,3]8==0 and SATAx1[B,3]4==0) for the amount of time specified by the SATAx1[C,4]4[DITO] ; If (SATAx24[DESO]==1), the HBA shall assert the DEVSLP signal after the port has been idle for the amount of time specified by SATAx1[C,4]4[DITO] and the interface is in Slumber state (SATAx1[A,2]8[IPM]==6h). This bit shall only be set to 1 if SATAx1[C,4]4[DSP]==1 .

3.26.3.3.3 Enclosure Buffer Management Registers

The Enclosure Buffer Management registers range from ([D11F0x24 \[AHCI Base Address \(BAR5\)\] + SATAx1C\[OFST\]*4 + 00h](#)) to ([D11F0x24 \[AHCI Base Address \(BAR5\)\] + SATAx1C\[OFST\]*4 + FFh](#)) within the memory mapped space.

SATA_EMx00 Message Header

Bits	Description
31:28	Reserved.
27:24	MTYPE: Message Type. Read-write. Reset: 0.
23:16	DSIZE: Data Size. Read-write. Reset: 0.
15:8	MSIZE: Message Size. Read-write. Reset: 0.
7:0	Reserved.

SATA_EMx04 Write SGPIO Register Request (I)

Bits	Description																
31:24	<p>REG_INDX: Register Index. Read-write. Reset: 0. Specifies the index of the first register in the bank to write. Currently supported index range is:</p> <table> <tr> <td><u>REG TYPE</u></td><td><u>REG INDEX</u></td></tr> <tr> <td>00h</td><td>0-1</td></tr> <tr> <td>03h</td><td>0</td></tr> <tr> <td>04h</td><td>0-7</td></tr> <tr> <td>0Ch</td><td>0</td></tr> </table> <p>It is software's responsibility to make sure the index of which the first register it attempts to access is valid and supported, as hardware does not provide a mechanism to return a status to software indicating that the current operation fails. An out-of-range index for a specific type of register is treated as don't care and none of the data for such index is written.</p>	<u>REG TYPE</u>	<u>REG INDEX</u>	00h	0-1	03h	0	04h	0-7	0Ch	0						
<u>REG TYPE</u>	<u>REG INDEX</u>																
00h	0-1																
03h	0																
04h	0-7																
0Ch	0																
23:16	<p>REG_TYPE: Register Type. Read-write. Reset: 0. Specifies the bank of registers to write. Currently supported Register Types are:</p> <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>0h</td><td>SGPIO Configuration</td></tr> <tr> <td>2h-1h</td><td>Reserved</td></tr> <tr> <td>3h</td><td>Transmit</td></tr> <tr> <td>4h</td><td>General Purpose Transmit</td></tr> <tr> <td>Bh-5h</td><td>Reserved</td></tr> <tr> <td>Ch</td><td>AMD Configuration</td></tr> <tr> <td>FFh-Dh</td><td>Reserved</td></tr> </table> <p>It is software's responsibility to make sure the type of registers that it attempts to access is valid and supported, as hardware does not provide a mechanism to return a status to software indicating that the current operation fails.</p>	<u>Bits</u>	<u>Definition</u>	0h	SGPIO Configuration	2h-1h	Reserved	3h	Transmit	4h	General Purpose Transmit	Bh-5h	Reserved	Ch	AMD Configuration	FFh-Dh	Reserved
<u>Bits</u>	<u>Definition</u>																
0h	SGPIO Configuration																
2h-1h	Reserved																
3h	Transmit																
4h	General Purpose Transmit																
Bh-5h	Reserved																
Ch	AMD Configuration																
FFh-Dh	Reserved																
15:8	FUNC: Function. Read-write. Reset: 0.																
7:0	FRAME_TYPE: Frame Type. Read-write. Reset: 0.																

SATA_EMx08 Write SGPIO Register Request (II)

Bits	Description										
31:8	Reserved.										
7:0	<p>REG_CNT: Register Count. Read-write. Reset: 0. Specifies the number of registers starting with the specified index to write. Currently supported register count range is:</p> <table> <tr> <td><u>REG TYPE</u></td><td><u>REG CNT</u></td></tr> <tr> <td>00h</td><td>1-2</td></tr> <tr> <td>03h</td><td>1</td></tr> <tr> <td>04h</td><td>1-8</td></tr> <tr> <td>0Ch</td><td>1</td></tr> </table> <p>It is software's responsibility to make sure the register count is valid and supported, as hardware does not provide a mechanism to return a status to software indicating that the current operation fails. An out-of-range register count for a specific type of register is treated as don't care and none of the data for such register count is written.</p>	<u>REG TYPE</u>	<u>REG CNT</u>	00h	1-2	03h	1	04h	1-8	0Ch	1
<u>REG TYPE</u>	<u>REG CNT</u>										
00h	1-2										
03h	1										
04h	1-8										
0Ch	1										

SATA_EMx0C Write SGPIO Register Request (III)

Bits	Description
255:0	DataRegister[7:0]: Data Register [7:0] . Read-write. Reset: 0. This field contains 256 bits of data registers ranging from (D11F0x24 [AHCI Base Address (BAR5)] + SATAx1C[OFST] * 4 + 0Ch) to (D11F0x24 [AHCI Base Address (BAR5)] + SATAx1C[OFST] * 4 + 2Bh). Once SATA_EMx04[REG_TYPE], SATA_EMx04[REG_INDX], and SATA_EMx08[REG_CNT] are specified, the values in this field is written to the internal copy of SGPIO registers.

3.26.4 USB Controllers

3.26.4.1 USB 2.0 (EHCI)

The EHCI controllers can be disabled by programming [PMxEF](#).

3.26.4.1.1 Devices 16h, 13h, 12h Function 0 (EHCI) Configuration Registers

See [3.1 \[Register Descriptions and Mnemonics\]](#) for a description of the register naming convention. See [2.7 \[Configuration Space\]](#) for details about how to access this space.

D[16,13,12]F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: Device ID. Read-only. Reset: 7808h. This 16-bit field is assigned by the device manufacturer and identifies the type of device.
15:0	VendorID: Vendor ID. Read-only. Reset: 1022h.

D[16,13,12]F0x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; write-1-to-clear. Reset: 0. 1=The EHCI controller detects a parity error.
30	SignaledSystemError: Signaled System Error. Read; write-1-to-clear. Reset: 0. 1=The EHCI controller asserted SERR#.
29	ReceivedMasterAbort: Received Master Abort. Read; write-1-to-clear. Reset: 0. 1=The EHCI controller received a PCI master abort while acting as a PCI master.
28	ReceivedTargetAbort: Received Target Abort. Read; write-1-to-clear. Reset: 0. 1=The EHCI controller generated PCI cycle (EHCI controller is the PCI master) is aborted by a PCI target.
27	SignaledTargetAbort: Signaled Target Abort. Read; write-1-to-clear. Read. Reset: 0. 1=The EHCI controller signals Target Abort.
26:25	DEVSELtiming: DEVSEL timing. Value: 01b. 01b=Medium timing.
24	MasterDataParityError: Master Data Parity Error. Read; write-1-to-clear. Reset: 0. 1=EHCI controller detects PERR# being asserted while acting as PCI master, regardless whether PERR# was driven by EHCI controller or not.
23	FastBack2BackCapable: Fast Back-to-Back Capable. Value: 1. 1=Indicates Fast Back-to-Back capable.
22	Reserved.
21	Capable66MHz: 66 MHz Capable. Value: 1. 1=Indicates 66 MHz capable.
20	CapabilitiesList: Capabilities List. Read-only. Reset: 1. 1=Indicates that the value read at D[16,13,12]F0x34 [Capability Pointer] is a pointer in Configuration Space to a linked list of new capabilities.
19	InterruptStatus: Interrupt Status. Read-only. Reset: 0. This bit reflects the state of the interrupt in the device/function.
18:11	Reserved.

10	InterruptDisable: Interrupt Disable. Read-write. Reset: 0. 0=Enable the assertion of the device/function's INTx# signal. 1=Disable the assertion of the device/function's INTx# signal.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Read-write. Reset: 0. 0=Only fast back-to-back transactions to the same agent are allowed. 1=The master is allowed to generate fast back-to-back transactions to different agents.
8	SERREnable: SERR# Enable. Read-write. Reset: 0. 0=Disable the SERR# driver. 1=Enable the SERR# driver.
7	RAZ.
6	ParityEnable: Parity Enable. Read-write. Reset: 0. 0=The device sets its DetectedParityError bit when an error is detected, but continues normal operations without asserting PERR#. 1=The device must take its normal action when a parity error is detected.
5	VgaPaletteRegisterAccesses: VGA palette register accesses. Value: 0. 0=The device treats palette write accesses the same as other accesses.
4	MemoryWriteAndInvalidateCommand: Memory Write and Invalidate Command. Read-write. Reset: 0. 0=Memory Write must be used. 1=Masters may generate the command.
3	SpecialCycle: Special Cycle. Value: 0. 0=Indicates no Special Cycle support.
2	BusMaster: Bus Master. Read-write. Reset: 0. 0=Disable the device from generating PCI accesses. 1=Allow the device to behave as a bus master.
1	MemorySpaceAccesses: Memory Space Accesses. Read-write. Reset: 0. 0=Disable the device response. 1=Allow the device to respond to memory space accesses.
0	IOSpaceAccesses: IO Space Accesses. Read-write. Reset: 0. 0=Disable the device response. 1=Allow the device to respond to IO space accesses.

D[16,13,12]F0x08 Revision ID / Class Code

Bits	Description
31:24	BC: Base Class. Value: 0Ch. 0Ch=Identifies the device being a Serial Bus Controller.
23:16	SC: Sub Class. Value: 3h. Sub Class. 03h=Identifies the device being of Universal Serial Bus.
15:8	PI: Programming Interface. Value: 20h. 20h=Identifies the device being an EHCI Host Controller.
7:0	RevisionID: Revision ID. Value: 39h.

D[16,13,12]F0x0C Miscellaneous

Bits	Description
31:24	Bist. Value: 0. 00h=BIST is not supported.
23:16	HeaderType: Header Type. Value: 00h. 00h=Indicates EHCI is single function.
15:8	LatencyTimer[7:0]: Latency Timer. Read-only. Reset: 0. This field specifies, in units of PCI bus clocks, the value of the Latency Timer for this PCI bus master.
7:0	CacheLineSize: Cache Line Size. Read-write. Reset: 0. Specifies the system cache line size in units of doublewords .

D[16,13,12]F0x10 BAR_EHCI

Bits	Description
31:8	BA: Base Address[31:8] . Read-write. Reset: 0. Specifies the MMIO Base address of the EHCI USB controller. See 3.26.4.1.2 [EHCI Memory Mapped IO Registers].
7:4	Reserved.
3	PM: Prefetch Memory . Value: 0. 0=Non-prefetchable memory region.
2:1	Type: base address register type . Read-only. Reset: 00b. 00b=32-bit base address register.
0	MemSpace: memory space type . Read-only. Reset: 0. 0=Memory mapped base address.

D[16,13,12]F0x2C Subsystem ID / Subsystem Vendor ID

Bits	Description
31:16	SubsystemID . Read; write-once. Reset: 7808h.
15:0	SubsystemVendorID . Read; write-once. Reset: 1022h.

D[16,13,12]F0x34 Capability Pointer

Bits	Description
31:8	Reserved.
7:0	CapabilityPointer: Capability Pointer . Read-only. IF (D[16,13,12]F0x50[PMEDisable]==0) THEN Reset: C0h. ELSEIF (D[16,13,12]F0x50[MSIDisable]==0) THEN Reset: D0h. ELSEIF (D[16,13,12]F0x50[FlrEn]==1) THEN Reset: F0h. ELSE Reset: 00h. ENDIF. Specifies the address of the first element of capability link.

D[16,13,12]F0x3C Interrupt Line

Bits	Description
31:24	MaxLat . Value: 00h.
23:16	MinGnt . Value: 00h.
15:8	InterruptPin: Interrupt Pin . Read-only. Reset: 01h. 01h=INTA#.
7:0	InterruptLine: Interrupt Line . Read-write. Reset: 0. Identifies which input on the interrupt controller the function's PCI interrupt request pin is routed to.

D[16,13,12]F0x50 EHCI Misc Control

This register is shared among all the EHCI controllers if (D[16,13,12]F0x64[ShareRegisterEnable]==1).

Bits	Description
31	PHYAdvancePowerSavingEnable: PHY Advance Power Saving Enable . Read-write. Reset: 1. 1=Enable the advance PHY power saving feature to save active power from the USB PHY.
30:29	Reserved.

28	DisableAsyncQHCACHEEnhancement: Disable Async QH Cache Enhancement. Read-write. Reset: 0. 1=Disable async QH/QTD cache enhancement.								
27	DisablePeriodicListCache: Disable Periodic List Cache. Read-write. Reset: 0. 1=Disable periodic list cache.								
26	DisableAsyncDataCache: Disable Async Data Cache. Read-write. Reset: 0. 1=Disable async data cache request.								
25	DisableAsyncQHCACHE: Disable Async QH Cache. Read-write. Reset: 0. 1=Disable async QH/QTD cache.								
24	AsyncQHCACHEThresholdControl: Async QH Cache Threshold Control. Read-write. Reset: 0. For OUT, 0=Cache only if packet size is greater than 128 Bytes. 1=Cache only if packet size is greater than 64 Bytes. For IN, 0=Cache only if expected packet size is greater than 192 Bytes. 1=Cache only if expected packet size is greater than 96 Bytes.								
23	AsyncParkDisable: async-park disable. Read-write. Reset: 0. 1=Disable async-park mode.								
22	Reserved.								
21	EnableIPGapExt: Enable InterPacket Gap Extension. Read-write. Reset: 1. 1=Enable inter-packet gap extension in PIE idle state on starting a new transaction.								
20	Reserved.								
19	QualifyCacheHit: Qualify Cache Hit. Read-write. Reset: 0. BIOS: 1. 1=Qualify cache hit with EHCI_RDWRN command.								
18	Reserved.								
17	AsyncParkCacheControl: Async Park Cache Control. Read-write. Reset: 1. 1=Enable async park cache control.								
16	Reserved.								
15:12	AsyncParkOUTControl: Async Park OUT Control. Read-write. Reset: 1. Async Park Mode Count for OUT Packet. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount].</td></tr> <tr> <td>1h</td><td>8 packets.</td></tr> <tr> <td>Fh-2h</td><td>Reserved.</td></tr> </table>	Bits	Definition	0h	Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount] .	1h	8 packets.	Fh-2h	Reserved.
Bits	Definition								
0h	Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount] .								
1h	8 packets.								
Fh-2h	Reserved.								
11:8	AsyncParkINControl: Async Park IN Control. Read-write. Reset: 1. Async Park Mode Count for IN Packet. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount].</td></tr> <tr> <td>1h</td><td>8 packets.</td></tr> <tr> <td>Fh-2h</td><td>Reserved.</td></tr> </table>	Bits	Definition	0h	Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount] .	1h	8 packets.	Fh-2h	Reserved.
Bits	Definition								
0h	Standard count as specified by EHCI[3:1]x20[AsyncScheduleParkModeCount] .								
1h	8 packets.								
Fh-2h	Reserved.								
7	EnablePerPortChangeEventCapability: Enable Per-Port Change Events Capability. Read-write. Reset: 0. Enable the support of Per-Port Change Event Capability. 1=Set EHCI[3:1]x08[PerPortChangeEventCapability] to 1. 0=Clear EHCI[3:1]x08[PerPortChangeEventCapability] to 0.								
6	MSIDisable: MSI Disable. Read-write. Reset: 0. BIOS: 1. 1=Disable MSI support.								
5	PMEDisable: PME Disable. Read-write. Reset: 0. 1=Disable PME support.								
4	EhciPmeLevelSignalByResumeWakeupEnable: EHCI PME level signal by resume-wakeup enable. Read-write. Reset: 0. 1=PME is a level signal instead of pulse when resume wake-up event is detected.								
3	Reserved.								

2	FlrEn: FLR Enable. Read-write. Reset: 0. 1=Enable FLR support.
1	DisableSMI: disable SMI. Read-write. Reset: 0. 1=Disable EHCI_SMI sent to USB SMI output (to ACPI). 0=Enable.
0	D3ColdPMEsupport: D3Cold PME support. Read-write. Reset: 0. BIOS: 1. 1=Enable EHCI host controller PME support at D3Cold. 0=Disable.

D[16,13,12]F0x54 EHCI Spare 1

This register is shared among all the EHCI controllers if (D[16,13,12]F0x64[ShareRegisterEnable]==1).

Bits	Description																				
31	UsbHoldS0ResumeEn. Read-write. Reset: 0. BIOS: 1. 0=Disable EHCI hold resume enhancement. 1=Enable EHCI hold resume enhancement.																				
30:27	Reserved.																				
26	EnMaskIntrOfD0: Enable masking interrupt out of D0 state. Read-write. Reset: 0. 0=Disable masking interrupt for all state, including D3hot. 1=Enable masking interrupt out of D0 state.																				
25:24	Reserved.																				
23	Reserved.																				
22:13	Reserved.																				
12:11	Reserved.																				
10	ResumePmeD123En: Resume PME in D123 Enable. Read-write. Reset: 0. 1=PME Status is set only in non-D0 state when resume occurs.																				
9:7	EhciL1EarlyExitTimer: EHCI L1 early exit timer. Read-write. Reset: 5h. BIOS: 100b. Timer to control EHCI L1 exit. When EhciL1EarlyExitEnable is set to 1, this field selects the amount of time before SOF that the EHCI controller requests UMI to exit from L1. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>20 us</td><td>100b</td><td>60 us</td></tr><tr><td>001b</td><td>30 us</td><td>101b</td><td>70 us</td></tr><tr><td>010b</td><td>40 us</td><td>110b</td><td>80 us</td></tr><tr><td>011b</td><td>50 us</td><td>111b</td><td>90 us</td></tr></table>	Bits	Definition	Bits	Definition	000b	20 us	100b	60 us	001b	30 us	101b	70 us	010b	40 us	110b	80 us	011b	50 us	111b	90 us
Bits	Definition	Bits	Definition																		
000b	20 us	100b	60 us																		
001b	30 us	101b	70 us																		
010b	40 us	110b	80 us																		
011b	50 us	111b	90 us																		
6	EhciL1EarlyExitMode: Ehci L1 early exit mode Read-write. Reset: 0. BIOS: 1. Mode selection bit for EHCI L1 early exit function. 0=Exit signal active in every uFrame if PDC schedule is enabled. 1=Exit signal active in current uFrame when detecting next uFrame has active PDC work.																				
5	EhciL1EarlyExitEnable: EHCI L1 early exit enable. Read-write. Reset: 0. BIOS: 1. 0=Disable. 1=Enable.																				
4	LSConnectionWakeUpEnable: LS connection wake up enable. Read-write. Reset: 1. 1=Enable wake up from S states for Low Speed (LS) connection. 0=Disable.																				
3	EhciEmptyListMode: EHCI empty list mode. Read-write. Reset: 1. 1=Enable empty list mode. 0=Disable.																				
2	EhciBlockCStateEnable: EHCI block-C-state enable. Read-write. Reset: 0. 1=Enable EHCI sending block-C-state signal to ACPI.																				
1	Reserved.																				
0	EhciDelayBifL1Enable: EHCI delay BIF L1 enable. Read-write. Reset: 0. 1=Enable EHCI delaying BIF on entering L1 when there are USB transactions on the controller and when USB delaying BIF L1 is enabled in A-link bridge.																				

D[16,13,12]F0x60 Serial Bus Release Number / FLADJ

Bits	Description
31:14	Reserved.
13:8	FLADJ: Frame Length Timing Value. Read-write. Reset: 20h. Each decimal value change to this register corresponds to 16 high-speed bit times. The SOF cycle time (number of SOF counter clock periods to generate a SOF micro-frame length)=59488 + 16*FLAdj.
7:0	SBRN: Serial Bus Release Number. Value: 20h.

D[16,13,12]F0x64 Misc Control 2

Bits	Description										
31:29	Reserved.										
28:24	PortDisable. Read; write-once; write-1-only. Reset: 0h. For each bit, 1=The corresponding port is disabled. <table><tr><td><u>Bit</u></td><td><u>Definition</u></td><td><u>Bit</u></td><td><u>Definition</u></td></tr><tr><td>[0]</td><td>Port 0</td><td>[1]</td><td>Port 1</td></tr></table>	<u>Bit</u>	<u>Definition</u>	<u>Bit</u>	<u>Definition</u>	[0]	Port 0	[1]	Port 1		
<u>Bit</u>	<u>Definition</u>	<u>Bit</u>	<u>Definition</u>								
[0]	Port 0	[1]	Port 1								
23:18	Reserved.										
17:16	Reserved.										
15:14	Port3ForceResetEnable. Read-write. Reset: 0. Enables "Force Reset in S-state" feature. See: Port0ForceResetEnable.										
13:12	Port2ForceResetEnable. Read-write. Reset: 0. Enables "Force Reset in S-state" feature. See: Port0ForceResetEnable.										
11:10	Port1ForceResetEnable. Read-write. Reset: 0. Enables "Force Reset in S-state" feature. See: Port0ForceResetEnable.										
9:8	Port0ForceResetEnable. Read-write. Reset: 0. Enables "Force Reset in S-state" feature. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Force port reset is disabled.</td></tr><tr><td>01b</td><td>Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states only when port is not connected.</td></tr><tr><td>10b</td><td>Force port reset is disabled.</td></tr><tr><td>11b</td><td>Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states regardless of port connection status.</td></tr></table>	<u>Bits</u>	<u>Definition</u>	00b	Force port reset is disabled.	01b	Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states only when port is not connected.	10b	Force port reset is disabled.	11b	Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states regardless of port connection status.
<u>Bits</u>	<u>Definition</u>										
00b	Force port reset is disabled.										
01b	Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states only when port is not connected.										
10b	Force port reset is disabled.										
11b	Host controller drives the corresponding port to reset state when system entering S3/S4/S5 states regardless of port connection status.										
7:5	Reserved.										
4	Reserved.										
3:2	Reserved.										
1	ShareRegisterEnable. Read-write. Reset: 1. 1=Enable register sharing among all EHCI controllers; Software can write to any enabled EHCI controller's share register and the same value is reflected into other EHCI controllers shared register. 0=Disable register sharing; The value written to one controller won't reflect in another equivalent controller. The registers that can be shared are: <ul style="list-style-type: none">• D[16,13,12]F0x50• D[16,13,12]F0x54•										

0	Reserved.
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D[16,13,12]F0x70 Over-Current Control 1

Bits	Description																								
31:20	Reserved.																								
19:16	Reserved.																								
15:12	HSPort3OverCurrentControl: HS Port 3 OverCurrent Control. Read-only. Reset: Fh. See: HSPort0OverCurrentControl.																								
11:8	HSPort2OverCurrentControl: HS Port 2 OverCurrent Control. Read-only. Reset: Fh. See: HSPort0OverCurrentControl.																								
7:4	HSPort1OverCurrentControl: HS Port 1 OverCurrent Control. Read-only. Reset: Fh. See: HSPort0OverCurrentControl.																								
3:0	HSPort0OverCurrentControl: HS Port 0 OverCurrent Control. Read-only. Reset: Fh. Specifies the OverCurrent pin mapping for port 0. There are 8 OverCurrent pins (USB_OC[7:0]), any value greater than 7 disables the OverCurrent function for port 0. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>0000b</td><td>USB_OC0#</td><td>0100b</td><td>USB_OC4#</td></tr><tr><td>0001b</td><td>USB_OC1#</td><td>0101b</td><td>USB_OC5#</td></tr><tr><td>0010b</td><td>USB_OC2#</td><td>0110b</td><td>USB_OC6#</td></tr><tr><td>0011b</td><td>USB_OC3#</td><td>0111b</td><td>USB_OC7#</td></tr><tr><td>1111b-1000b</td><td>Disable OverCurrent</td><td></td><td></td></tr></table>	Bits	Definition	Bits	Definition	0000b	USB_OC0#	0100b	USB_OC4#	0001b	USB_OC1#	0101b	USB_OC5#	0010b	USB_OC2#	0110b	USB_OC6#	0011b	USB_OC3#	0111b	USB_OC7#	1111b-1000b	Disable OverCurrent		
Bits	Definition	Bits	Definition																						
0000b	USB_OC0#	0100b	USB_OC4#																						
0001b	USB_OC1#	0101b	USB_OC5#																						
0010b	USB_OC2#	0110b	USB_OC6#																						
0011b	USB_OC3#	0111b	USB_OC7#																						
1111b-1000b	Disable OverCurrent																								

D[16,13,12]F0x74 Misc Control 2

Bits	Description
31:6	Reserved.
5	SptShortPktIntEn. Read-write. Reset: 1. 1=Enable. 0=Disable.
4	Reserved.
3	ShortPktIntInSplitEn. Read-write. Reset: 0. BIOS: 1. 1=Enable. 0=Disable.
2	AlinkPsEnable. Read-write. Reset: 0. BIOS: 1. 1=Enable dynamic A-link gating. 0=AlinkClk is not gated.
1:0	Reserved.

D[16,13,12]F0x78 Target Timeout Control

Bits	Description
31:24	TimeoutTimer: Timeout Timer. Read-write. Reset: 80h. Timer to control the purge of the delay queue when the master that has initiated the access does not return to complete the transaction. After the timer expires, the queue is invalidated and the next transaction is serviced.
23:8	Reserved.

7:0	RetryCounter: Retry Counter. Read-write. Reset: FFh. Counter to control the purge of the delay queue when the downstream access cycle is not completed within certain time. The transaction is target aborted when the counter expired. 0=The retry counter is disabled.
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D[16,13,12]F0x80 Hub Config 0

Bits	Description
31:16	DeviceID. Read-write. Reset: 7900h. Assigned by the device manufacturer and identifies the type of device.
15:0	VendorID. Read-write. Reset: 0438h.

D[16,13,12]F0x84 Hub Config 1

Bits	Description										
31	Reserved.										
30	Reserved.										
29	Reserved.										
28	Disable_FORCE_FS_MODE. Read-write. Reset: 1. 0=Force Fs Mode, related hub downstream ports are forced into full speed mode when a high speed capable device is connected. 1=All hub downstream ports behaves as at usb2.0 spec defines (not forced into full speed mode) during usb bus enumeration.										
27:26	Reserved.										
25:24	HubCfgOCDebounce. Read-write. Reset: 11b. BIOS: 00b. Adjusts the over-current detection (OC_DET) de-bounce logic. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>OC_DET has de-bounce timer set to 4~5 ms</td></tr> <tr> <td>01b</td><td>OC_DET has de-bounce timer set to 170~213 us</td></tr> <tr> <td>10b</td><td>OC_DET has de-bounce timer set to ~3 us</td></tr> <tr> <td>11b</td><td>OC_DET has de-bounce timer set close to 20 ns</td></tr> </table>	Bits	Definition	00b	OC_DET has de-bounce timer set to 4~5 ms	01b	OC_DET has de-bounce timer set to 170~213 us	10b	OC_DET has de-bounce timer set to ~3 us	11b	OC_DET has de-bounce timer set close to 20 ns
Bits	Definition										
00b	OC_DET has de-bounce timer set to 4~5 ms										
01b	OC_DET has de-bounce timer set to 170~213 us										
10b	OC_DET has de-bounce timer set to ~3 us										
11b	OC_DET has de-bounce timer set close to 20 ns										
23	WkOnConEn. Read-write. Reset: 1. Controls the hub behavior of wake on connect when the hub is in global suspend state. 0=Hub does not initiate resume on the upstream port, nor assert CLK_REQ signal when it detects a connect event. 1=Enable hub to initiate resume on the upstream port and assert CLK_REQ signal when it detects a connect event and the Remote Wakeup Enable feature is enabled.										
22	WkOnDisConEn. Read-write. Reset: 1. Controls the hub behavior of wake on disconnect when the hub is in global suspend state. 0=Hub does not initiate resume on the upstream port, nor assert CLK_REQ signal when it detects a disconnect event. 1=Enable hub to initiate resume on the upstream port and assert CLK_REQ signal when it detects a disconnect event and the Remote Wakeup Enable feature is enabled.										
21	WkOnOvrCurEn. Read-write. Reset: 1. Controls the hub behavior of wake on over current when the hub is in global suspend state. 0=Hub does not initiate resume on the upstream port, nor assert CLK_REQ signal when it detects an over current event. 1=Enable hub to initiate resume on the upstream port and assert CLK_REQ signal when it detects an over current event and the Remote Wakeup Enable feature is enabled.										

20	WkOnDevRsmEn. Read-write. Reset: 1. Controls the hub behavior of wake on device resume when the HUB is in global suspend state. 0=Hub does not initiate resume on the upstream port, nor assert CLK_REQ signal when it detects resume on downstream port. 1=Enable hub to initiate resume on the upstream port and assert CLK_REQ signal when it detects resume on downstream port.
19	PdbMode. Read-write. Reset: 1. Specifies how PORT_PDB_P signal is asserted. 0=PORT_PDB_P is asserted when the downstream port state is Not Configured, Powered-off, Disconnected, Disabled or Suspend; PORT_PDB_P is also asserted when U2HUB_TOP is in Global Suspend. 1=PORT_PDB_P is asserted when the downstream port state is Not Configured, Powered-off, Disconnected, Disabled, Suspend or L1-Suspend; PORT_PDB_P is also asserted when U2HUB_TOP is in Global Suspend.
18	GSusMaskB. Read-write. Reset: 1. Masks the CLK_REQ signal deassertion. 0=Masked. 1=Not Masked.
17	PwrConf. Read-write. Reset: 1. Indicates the hub power configuration. 0=Bus Powered hub configuration. 1=Self/bus powered hub configuration.
16	LpmEn. Read-write. Reset: 0. Specifies whether to support the L1 state.
15:0	BcdDevice[15:0]. Read-write. Reset: 0018h. This represents the current revision of the hub device. Bit[7:3] represents major revision, and bit[2:0] represents the minor revision.

D[16,13,12]F0x88 HUB Config 2

Bits	Description
31:24	BcdUsbLow[7:0]. Read-write. Reset: 00h.
23:16	FLAdj[7:0]. Read-write. Reset: 20h. Specifies Frame Length Adjustment value. Each decimal value change to this field corresponds to 16 high-speed bit times. The SOF cycle time (number of SOF counter clock periods to generate a SOF micro-frame length)=59488 + 16*FLAdj.
15:8	BESLValue[7:0]. Read-write. Reset: 00h.
7	VBusM. Read-write. Reset: 1. Indicates the VBUS state. 0=VBUS not detected. 1=VBUS detected.
6:4	BESLValid[2:0]. Read-write. Reset: 0.
3:0	TL1HubDrvResume2[3:0]. Read-write. Reset: 1. Sets the length of resume to be driven for the remote wake of the L1 port device.

D[16,13,12]F0x8C HUB Config 3

The reset value depends on the number of Hub Down Stream Ports (DSP).

Table 257: Reset mapping for D[16,13,12]F0x8C

Register	Reset
D12F0x8C	6400_7EC7h
D13F0x8C	6400_7EC7h
D16F0x8C	6400_7EA7h

Bits	Description
31:24	bHubCtrCurrent[7:0]. Read-write.
23:16	bMaxPower[7:0]. Read-write.

15:9	Removable[7:1] . Read-write. Specifies the removable state for each port. 0=Non-removable port. 1=Removable port.
8	Reserved.
7	LPwrSt . Read-write. Indicates the local power state. 0=Local Power Off. 1=Local Power On.
6:4	N_Port[2:0] . Read-write. Indicates the number of available ports for use. D12F0 and D13F0 has 4 ports as Max, The settable range is 2 to 4. D16F0 has 2 ports as max, The settable range is 2.
3	Po2PgSel . Read-write. 0=0 ms. 1=100 ms.
2	LedB . Read-write. Specifies port indicator bit support. 0=LED is supported. 1=LED is unsupported.
1	BusB . Read-write. Indicates the current operating mode. 0=Bus powered mode. 1=Self powered mode.
0	GangB . Read-write. 0=Ganged power switching mode. 1=Individual power switching mode.

D[16,13,12]F0x9C HUB Status

Bits	Description
31:27	Reserved.
26	L1SpndO . Read-only. Reset: 0. 1=The upstream port state machine is in the L1_SPND_O state.
25	SpndO . Read-only. Reset: 0. 1=The upstream port state machine is in the SPND_O state.
24	RmWkUpEn . Read-only. Reset: 0. Indicates the remote wakeup enable bit state. The original signal is not overridden by LPM transactions. 0=Remote wake up is disabled. 1=Remote wake up is enabled.
23:20	Reserved.
19:16	PrtGreenLedB[3:0] . Read-only. Reset: X. Specifies the green LED control for each port. For each bit, 0=LED On. 1=LED Off.
15:12	Reserved.
11:8	PrtAmberLedB[3:0] . Read-only. Reset: X. Specifies the amber LED control for each port. For each bit, 0=LED On. 1=LED Off.
7:4	Reserved.
3:0	PrtPowerB[3:0] . Read-only. Reset: X. Specifies the power control in each port.

D[16,13,12]F0xA0 USB Legacy Support Extended Capability

Bits	Description
31:25	Reserved.
24	HcOsOwnedSemaphore . Read-write. Reset: 0. System software sets this bit to request ownership of the EHCI controller. Ownership is obtained when this bit reads as 1 and the HcBiosOwnedSemaphore reads as 0.
23:17	Reserved.
16	HcBiosOwnedSemaphore . Read-write. Reset: 0. The BIOS sets this bit to establish ownership of the EHCI controller. System BIOS sets this bit to a 0 in response to a request for ownership of the EHCI controller by system software.
15:8	NextEhciExtendedCapabilityPointer . Read-only. Reset: 00h. 00h=The end of the extended capability list.

7:0	CapabilityID. Read-only. Reset: 01h. 01h=Legacy Support.
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D[16,13,12]F0xA4 USB Legacy Support Control / Status

Bits	Description
31	SmiOnBar. Read; Set-by-hardware; write-1-to-clear. Reset: 0. 1=The Base Address Register (BAR) is written.
30	SmiOnPciCommand. Read; Set-by-hardware; write-1-to-clear. Reset: 0. 1=The PCI Command Register is written.
29	SmiOnOsOwnershipChange. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=D[16,13,12]F0xA0[HcOsOwnedSemaphore] transitions from 1 to 0 or 0 to 1.
28:22	Reserved.
21	SmiOnAsyncAdvance. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[InterruptOnAsyncAdvance]. Writing 1 to EHCI[3:1]x24[InterruptOnAsyncAdvance] clears this bit to 0.
20	SmiOnHostSystemError. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[HostSystemError]. Writing 1 to EHCI[3:1]x24[HostSystemError] clears this bit to 0.
19	SmiOnFrameListRollover. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[FrameListRollover]. Writing 1 to EHCI[3:1]x24[FrameListRollover] clears this bit to 0.
18	SmiOnPortChangeDetect. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[PortChangeDetect]. Writing 1 to EHCI[3:1]x24[PortChangeDetect] clears this bit to 0.
17	SmiOnUsbError. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[UsbErrInt]. Writing 1 to EHCI[3:1]x24[UsbErrInt] clears this bit to 0.
16	SmiOnUsbComplete. Read-only. Reset: 0. This is the shadow bit of EHCI[3:1]x24[UsbInt]. Writing 1 to EHCI[3:1]x24[UsbInt] clears this bit to 0.
15	SmiOnBarEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnBAR==1.
14	SmiOnPciCommandEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnPciCommand==1.
13	SmiOnOsOwnershipEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnOsOwnershipChange==1.
12:6	Reserved.
5	SmiOnAsyncAdvanceEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnAsyncAdvance==1.
4	SmiOnHostSystemErrorEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnHostSystemError==1.
3	SmiOnFrameListRolloverEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnFrameListRollover==1.
2	SmiOnPortChangeEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnPortChangeDetect==1.
1	SmiOnUsbErrorEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnUsbError==1.
0	UsbSmiEnable. Read-write. Reset: 0. 1=The host controller issues an SMI if SmiOnUsbComplete==1.

D[16,13,12]F0xC0 PME Capability

Bits	Description												
31:27	PmeSupport[4:0] . Read-only. Reset: 0Fh. Indicates the power states in which the function may assert PME#. For each bit, 0=the function is not capable of asserting the PME# signal while in that power state. <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>1=PME# can be asserted from D0</td></tr> <tr> <td>[1]</td><td>1=PME# can be asserted from D1</td></tr> <tr> <td>[2]</td><td>1=PME# can be asserted from D2</td></tr> <tr> <td>[3]</td><td>1=PME# can be asserted from D3hot</td></tr> <tr> <td>[4]</td><td>1=PME# can be asserted from D3cold</td></tr> </table>	<u>Bit</u>	<u>Definition</u>	[0]	1=PME# can be asserted from D0	[1]	1=PME# can be asserted from D1	[2]	1=PME# can be asserted from D2	[3]	1=PME# can be asserted from D3hot	[4]	1=PME# can be asserted from D3cold
<u>Bit</u>	<u>Definition</u>												
[0]	1=PME# can be asserted from D0												
[1]	1=PME# can be asserted from D1												
[2]	1=PME# can be asserted from D2												
[3]	1=PME# can be asserted from D3hot												
[4]	1=PME# can be asserted from D3cold												
26	D2Support . Read-only. Reset: 1. 1=This function supports the D2 Power Management State.												
25	D1Support . Read-only. Reset: 1. 1=This function supports the D1 Power Management State.												
24:22	AuxCurrent . Value: 0. Reports the 3.3V auxiliary current requirements for the PCI function. 0=Self-powered.												
21	DSI: device specific initialization . Value: 0. Indicates whether special initialization of this function is required before the generic class device driver is able to use it.												
20	Reserved.												
19	PmeClock: PME clock . Value: 0. 0=Indicates that no PCI clock is required for the function to generate PME#.												
18:16	Version . Read-only. Reset: 2h. 2h=Indicates that this function complies with Revision 1.1 of the PCI Power Management Interface Specification.												
15:8	NextItemPointer: next item pointer . Read-only. Reset: D0h. Specifies the address of the next capability structure.												
7:0	CapId: capability ID . Value: 01h. Identifies the linked list items as being the PCI Power Management registers.												

D[16,13,12]F0xC4 PME Control / Status

Bits	Description
31:16	Reserved.
15	PmeStatus . Read; set-by-hardware; write-1-to-clear. Cold reset: 0. 1=PME# signal is asserted, independent of the state of the PmeEn bit.
14:9	Reserved.
8	PmeEn . Read-write. Cold reset: 0. 1=Enables the function to assert PME#. 0=PME# assertion is disabled.
7:2	Reserved.

1:0	PowerState. Read-write. Reset: 0. This 2-bit field is used both to determine the current power state of a function and to set the function into a new power state. If software attempts to write an unsupported, optional state to this field, the write operation must be completed normally on the bus; however, the data is discarded and no state change occurs.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	D0	10b	D2
	01b	D1	11b	D3hot

D[16,13,12]F0xD0 MSI Control

Bits	Description
31:24	Reserved.
23	C64: 64-bit Address Capable. Read-only. IF (EHCI[3:1]x08[AddressingCapability64Bit]==1) THEN Reset: 1. ELSE Reset: 0. ENDIF. 1=Indicates that the EHCI is capable of generating a 64-bit message address. 0=Indicates the EHCI is not capable of generating a 64-bit address.
22:20	MSIControl: MSI Control. Read-write. Reset: 0.
19:17	Reserved.
16	MSIE: MSI Enable. Read-write. Reset: 0. 1=MSI is enabled and the traditional pins are not used to generate interrupts. 0=MSI operation is disabled and the traditional interrupt pins are used.
15:8	NextItemPointer: Next Item Pointer. Read-only. Reset: E4h. Pointer to next capability structure.
7:0	CapabilityID. Read-only. Reset: 5h. Indicates this is USB MSI capability ID.

D[16,13,12]F0xD4 MSI Address

Bits	Description
31:2	MsiAddress: MSI Address. Read-write. Reset: 0. Specifies system specified message address [31:2].
1:0	Reserved.

D[16,13,12]F0xD8 MSI Upper Address

Bits	Description
31:0	MsiUpperAddress: MSI Upper Address. Read-write. Reset: 0. IF (D[16,13,12]F0xD0[C64]==1) THEN This field specifies the upper 32 bit of system specific message address [63:32]. ELSE This field specifies the MSI data. ENDIF.

D[16,13,12]F0xDC MSI Data

Bits	Description
31:0	MsiData: MSI Data. Read-write. Reset: 0. IF (D[16,13,12]F0xD0[C64]==1) THEN This field specifies the MSI data. ELSE This field is reserved. ENDIF.

D[16,13,12]F0xF0 Function Level Reset Capability

IF (D[16,13,12]F0x50[FlrEn]==0) THEN

Bits	Description
31:0	Reserved.

ELSE

Bits	Description
31:26	Reserved.
25	FunctionLevelResetCapability: Function Level Reset Capability. Value: 1. 1=Function level reset support.
24	TransactionPendingCapability. Value: 1. 1=Transaction pending feature is supported.
23:16	Length. Read-only. Reset: 6h. Advanced Feature (AF) structure length (byte).
15:8	NextItemPointer: Next Item Pointer. Value: 0. Pointer to next capability structure. 0=This is the final item on the list.
7:0	CapId. Read-only. Reset: 13h. 13h=Identifies that the function is Advanced Feature (AF) capable.

ENDIF.

D[16,13,12]F0xF4 Function Level Reset Control

IF (D[16,13,12]F0x50[FlrEn]==0) THEN

Bits	Description
31:0	Reserved.

ELSE

Bits	Description
31:9	Reserved.
8	TransactionPending. Read-only; updated-by-hardware. Reset: 0. 1=Indicates that the Function has issued one or more non-posted transactions which have not been completed, including non-posted transactions that a target has terminated with Retry. 0=Indicates that all non-posted transactions have been completed.
7:1	Reserved.
0	InitiateFLR: Initiate FLR. RAZ; write-1-only. Reset: 0. 1=Initiates Function Level Reset (FLR).

ENDIF.

3.26.4.1.2 EHCI Memory Mapped IO Registers

The EHCI MMIO base address is specified by D[16,13,12]F0x10[BA]. For details of ECHI USB controller implementation requirements and behavior consult the *Universal Serial Bus Specification 2.0* and *Enhanced Host Controller Interface Specification for Universal Serial Bus*.

EHCI[3:1]x00 Capability Length

Bits	Description
7:0	CapLength. Value: 20h. This register is used as an offset to add to the register base to find the beginning of the Operational Register Space starting at EHCI[3:1]x20 .

EHCI[3:1]x02 HC Interface Version

Bits	Description
15:0	HciVersion. Value: 100h. Specifies a BCD encoding of the version number of interface to which this host controller interface conforms.

EHCI[3:1]x04 HC Structural Parameters**Table 258: Reset mapping for [EHCI\[3:1\]x04](#)**

Register	Reset
EHCI1x04	0020_0004h
EHCI2x04	0020_0004h
EHCI3x04	0020_0002h

Bits	Description
31:24	Reserved.
23:20	DebugPortNumber. Read-only. This register identifies which of the host controller ports is the debug port. The value is the port number (one-based) of the debug port. A non-zero value in this field indicates the presence of a debug port. The value in this register must not be greater than EHCI[3:1]x04[NPorts] .
19:17	Reserved.
16	PortIndicators. Read-only. Indicates whether the ports support port indicator control. 1=The port status and control registers include a read/writable field for controlling the state of the port indicator.
15:12	N_CC: number of companion controllers. Read-only. Indicates the number of companion controllers associated with this USB 2.0 host controller. A value larger than 0 in this field indicates there are companion USB 1.1 host controller(s). Port-ownership handoffs are supported. High-speed, Full-speed and Low-speed devices are supported on the host controller root ports.
11:8	N_PCC: NumberOfPortsPerCompanionController. Read-only. Indicates the number of ports supported per companion host controller. It is used to indicate the port routing configuration to system software.
7	PortRoutingRules. Read-only. Specifies how all ports are mapped to companion controllers. 0=The first N_PCC ports are routed to the lowest numbered function companion host controller, the next N_PCC port are routed to the next lowest function companion controller, and so on.
6:5	Reserved.
4	PPC: PortPowerControl. Read-only. Specifies whether the host controller implementation includes port power control. 0=The port does not have port power switches. The value of this field affects the functionality of EHCI[3:1]x[70,6C,68,64][PortPower] .

3:0	NPorts. Read-only. Specifies the number of physical downstream ports implemented on this host controller. The value of this field determines how many port registers are addressable in the Operational Register Space.
<u>Bits</u>	<u>Definition</u>
0h	undefined
Fh-1h	<NPorts> Ports

EHCI[3:1]x08 HC Capability Parameters

Bits	Description
31:20	Reserved.
19	Frame32PeriodicListCapability: 32-Frame Periodic List Capability. Read-only. Reset: 0. 0=Software must treat a Frame List Size value of 11b as reserved.
18	PerPortChangeEventCapability: Per-Port Change Event Capability. Value: D[16,13,12]F0x50 [EnablePerPortChangeEventsCapability]. 1=Host controller supports per-port change events and the associated fields EHCI[3:1]x20 [PerPortChangeEventsEnable], EHCI[3:1]x24 [PortNChangeDetect] and EHCI[3:1]x28 [PortChangeIntEn]. 0=Per-port change events are not supported; software should treat those fields as reserved.
17	LinkPowerManagementCapability: Link Power Management Capability. Read-only. Reset: 0. 0=Link Power Management L1 State is not supported.
16	HardwarePrefetchCapability: Hardware Prefetch Capability. Read-only. Reset: 0. 0=Hardware prefetch capability is not supported.
15:8	EhciExtendedCapabilitiesPointer. Read-only. Reset: A0h. Specifies the offset in PCI configuration space of the first EHCI extended capability. See D[16,13,12]F0xA0 .
7	IsochronousSchedulingThreshold3. Read-only. Reset: 0. The value of this field determines the function of IsochronousSchedulingThreshold[2:0].
6:4	IsochronousSchedulingThreshold[2:0]. Read-only. Reset: 111b. This field indicates, relative to the current position of the executing host controller, where software can reliably update the isochronous schedule. IF (IsochronousSchedulingThreshold3==0) THEN Field value indicates the number of micro-frames of isochronous data structures (one or more) a host controller can hold before flushing the state. ELSE Host software assumes the host controller may cache an isochronous data structure for an entire frame. ENDIF.
3	Reserved.
2	AsyncScheduleParkCapability. Read-only. Reset: 1. 1=The host controller supports the park feature for high-speed queue heads in the Asynchronous Schedule.
1	ProgrammableFrameListFlag. Read-only. Reset: 1. 0= EHCI[3:1]x20 [FrameListSize] is read-only; System software must use a frame list length of 1024 elements with this host controller. 1= EHCI[3:1]x20 [FrameListSize] is read-writeable; System software can specify and use a smaller frame list via EHCI[3:1]x20 [FrameListSize].
0	AddressingCapability64Bit. Read-only. Reset: 0. Specifies the addressing range capability of this implementation. 0=Data structures using 32-bit address memory pointers. 1=Data structures using 64-bit address memory pointers.

EHCI[3:1]x20 USB Command

Bits	Description																				
31:28	Reserved.																				
27:24	HostInitiatedResumeDuration: host-initiated resume duration. Read-only. Reset: 0. This field is used by system software to specify the minimum amount of time the host controller drives the K-state during a host-initiated resume from a LPM state (e.g. L1), and is conveyed to each LPM-enabled device (via the HIRD bits within an LPM Token’s bmAttributes field) upon entry into a low-power state. <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>Fh-0h</td><td>(<HostInitiatedResumeDuration> *75 us) + 50 us</td></tr></table>	Bits	Definition	Fh-0h	(<HostInitiatedResumeDuration> *75 us) + 50 us																
Bits	Definition																				
Fh-0h	(<HostInitiatedResumeDuration> *75 us) + 50 us																				
23:16	InterruptThresholdControl: Interrupt Threshold Control. Read-write. Reset: 8h. This field is used by system software to select the maximum rate at which the host controller issues interrupts. The only valid values are defined below. Any other value in this register yields undefined results. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00h</td><td>Reserved</td><td>08h</td><td>8 micro-frames (default, 1 ms)</td></tr><tr><td>01h</td><td>1 micro-frame</td><td>10h</td><td>16 micro-frames (2 ms)</td></tr><tr><td>02h</td><td>2 micro-frames</td><td>20h</td><td>32 micro-frames (4 ms)</td></tr><tr><td>04h</td><td>4 micro-frames</td><td>40h</td><td>64 micro-frames (8 ms)</td></tr></table> Software modifications to this bit while (EHCI[3:1]x24[HCHalted]==0) results in undefined behavior.	Bits	Definition	Bits	Definition	00h	Reserved	08h	8 micro-frames (default, 1 ms)	01h	1 micro-frame	10h	16 micro-frames (2 ms)	02h	2 micro-frames	20h	32 micro-frames (4 ms)	04h	4 micro-frames	40h	64 micro-frames (8 ms)
Bits	Definition	Bits	Definition																		
00h	Reserved	08h	8 micro-frames (default, 1 ms)																		
01h	1 micro-frame	10h	16 micro-frames (2 ms)																		
02h	2 micro-frames	20h	32 micro-frames (4 ms)																		
04h	4 micro-frames	40h	64 micro-frames (8 ms)																		
15	PerPortChangeEventEnable: Per-Port Change Events Enable. IF (EHCI[3:1]x08[PerPortChangeEventCapability]==1) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0. 1=Enable the per-port change event capability as defined by EHCI[3:1]x24[PortNChangeDetect] and EHCI[3:1]x28[PortNChangeEventEnable].																				
14	FullySynchronizedPrefetch: Fully Synchronized Prefetch. Read-only. Reset: 0.																				
13	AsynchronousSchedulePrefetchEnable: Asynchronous Schedule Prefetch Enable. Read-only. Reset: 0.																				
12	PeriodicSchedulePrefetchEnable: Periodic Schedule Prefetch Enable. Read-only. Reset: 0.																				
11	AsyncScheduleParkModeEnable: asynchronous schedule park mode enable. Read-write. Reset: 1. 1=Park mode is enabled. 0=Park mode is disabled.																				
10	Reserved.																				
9:8	AsyncScheduleParkModeCount: Asynchronous Schedule Park Mode Count. Read-write. Reset: 11b. This field contains a count of the number of successive transactions the host controller is allowed to execute from a high-speed queue head on the Asynchronous schedule before continuing traversal of the Asynchronous schedule. Valid values are 1h to 3h. <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>Reserved</td></tr><tr><td>11b-01b</td><td><AsyncScheduleParkModeCount> Successive transactions.</td></tr></table> Writing 00b to this field while (AsyncScheduleParkModeEnable==1) results in undefined behavior.	Bits	Definition	00b	Reserved	11b-01b	<AsyncScheduleParkModeCount> Successive transactions.														
Bits	Definition																				
00b	Reserved																				
11b-01b	<AsyncScheduleParkModeCount> Successive transactions.																				
7	LightHostControllerReset: Light Host Controller Reset. Read-only. Reset: 0. Not implemented.																				

6	InterruptOnAsyncAdvanceDoorbell: Interrupt on Async Advance Doorbell. Read; cleared-by-hardware; write-1-only. Reset: 0. This bit is used as a doorbell by software to tell the host controller to issue an interrupt the next time it advances asynchronous schedule. Software must write a 1 to this bit to ring the doorbell. When the host controller has evicted all appropriate cached schedule state, it sets EHCI[3:1]x24[InterruptOnAsyncAdvance] to 1 and clears this bit to 0. Writing 1b to this field while (AsynchronousScheduleEnable ==0) results in undefined behavior.												
5	AsynchronousScheduleEnable: Asynchronous Schedule Enable. Read-write. Reset: 0. This bit controls whether the host controller skips processing the Asynchronous Schedule. 0=Do not process the Asynchronous Schedule. 1=Use EHCI[3:1]x38 to access Asynchronous Schedule.												
4	PeriodicScheduleEnable: Periodic Schedule Enable. Read-write. Reset: 0. This bit controls whether the host controller skips processing the Periodic Schedule. 0=Do not process the Periodic Schedule. 1=Use EHCI[3:1]x34 to access the Periodic Schedule.												
3:2	FrameListSize: frame list size. IF ((EHCI[3:1]x08[ProgrammableFrameListFlag] ==1) (EHCI[3:1]x08[Frame32PeriodicListCapability] ==1)) THEN Read-write. ELSE RAZ. ENDIF. Reset: 0. This field specifies the size of the frame list. The size the frame list controls which bits in the Frame Index Register should be used for the Frame List Current index. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>1024 frames (4096 bytes)</td><td>01b</td><td>512 frames (2098 bytes)</td></tr><tr><td>10b</td><td>256 frames (1024 bytes)</td><td>11b</td><td>Reserved or 32 frames (see below)</td></tr></table> Software may only program a 32 frame list when EHCI[3:1]x08[Frame32PeriodicListCapability] =1, and a 512 or 256 frame list when EHCI[3:1]x08[ProgrammableFrameListFlag] =1.	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	1024 frames (4096 bytes)	01b	512 frames (2098 bytes)	10b	256 frames (1024 bytes)	11b	Reserved or 32 frames (see below)
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	1024 frames (4096 bytes)	01b	512 frames (2098 bytes)										
10b	256 frames (1024 bytes)	11b	Reserved or 32 frames (see below)										
1	HCRESET: Host Controller Reset. Read; cleared-by-hardware; write-1-only. Reset: 0. This control bit is used by software to reset the host controller. The effects of this on Root Hub registers are similar to a Chip Hardware Reset. Software must reinitialize the host controller in order to return the host controller to an operational state. 1=The Host Controller resets its internal pipelines, timers, counters, state machines, etc. to their initial value; Any transaction currently in progress on USB is immediately terminated; A USB reset is not driven on downstream ports; PCI Configuration registers are not affected by this reset; All operational registers, including port registers and port state machines are set to their initial values; Port ownership reverts to the companion host controller(s). Software should not set this bit to a 1 when EHCI[3:1]x24[HCHalted] ==0. Attempting to reset an actively running host controller results in undefined behavior.												
0	RunStop: Run/Stop. Read-write. Reset: 0. 1=Run; the Host Controller proceeds with execution of the schedule as long as this bit is set to 1. 0=Stop; the Host Controller completes the current and any actively pipelined transactions on the USB and then halts within 16 micro-frames after software clears this bit. Writing 1b to this field while (EHCI[3:1]x24[HCHalted] ==0) results in undefined behavior.												

EHCI[3:1]x24 USB Status

Bits	Description
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31:16	<p>PortNChangeDetect: Port-n Change Detect. IF (EHCI[3:1]x08[PerPortChangeEventCapability]==1) THEN Read; set-by-hardware; write-1-to-clear. ELSE Read-only. ENDIF. Reset: 0. This field should only be used by software when (EHCI[3:1]x20[PerPortChangeEventsEnable]==1). Each bit in this field correspond to a port. For each bit, 1=A port change event was detected for that port; see EHCI[3:1]x24[PortChangeDetect] for port change event details. EHCI[3:1]x04[NPorts] specifies how many ports are exposed by the host controller and thus how many bits in this field are valid.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>Port 1</td></tr> <tr> <td>[1]</td><td>Port 2</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>[15]</td><td>Port 16</td></tr> </table>	Bit	Definition	[0]	Port 1	[1]	Port 2	[15]	Port 16
Bit	Definition										
[0]	Port 1										
[1]	Port 2										
...	...										
[15]	Port 16										
15	<p>AsynchronousScheduleStatus: Asynchronous Schedule Status. Read-only. Reset: 0. The bit reports the current real status of the Asynchronous Schedule. 0=Status of the Asynchronous Schedule is disabled. 1=Status of the Asynchronous Schedule is enabled. The host controller is not required to immediately disable or enable the Asynchronous Schedule when software transitions EHCI[3:1]x20[AsynchronousScheduleEnable]. When this bit and the EHCI[3:1]x20[AsynchronousScheduleEnable] are the same value, the Asynchronous Schedule is either enabled (1) or disabled (0).</p>										
14	<p>PeriodicScheduleStatus: Periodic Schedule Status. Read-only. Reset: 0. The bit reports the current real status of the Periodic Schedule. 0=Periodic Schedule is disabled. 1=Periodic Schedule is enabled. The host controller is not required to immediately disable or enable the Periodic Schedule when software transitions EHCI[3:1]x20[PeriodicScheduleEnable]. When this bit and the Periodic Schedule Enable bit are the same value, Periodic Schedule is either enabled (1) or disabled (0).</p>										
13	<p>Reclamation. Read-only. Reset: 0. Indicates an empty asynchronous schedule.</p>										
12	<p>HCHalted. Read-only. Reset: 1. 0=EHCI[3:1]x20[RunStop] is 1 or the host controller has not yet stopped. 1=The host controller has stopped executing as a result of EHCI[3:1]x20[RunStop] being set to 0, either by software or by the host controller hardware due to an internal error.</p>										
11:6	Reserved.										
5	<p>InterruptOnAsyncAdvance: Interrupt on Async Advance. Read-write. Reset: 0. 1=Indicate the assertion of interrupt source caused by EHCI[3:1]x20[InterruptOnAsyncAdvanceDoorbell].</p>										
4	<p>HostSystemError: Host System Error. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=A serious error occurs during a host system access involving the host controller module. In a PCI system, conditions that set this bit to 1 include PCI Parity error, PCI Master Abort, and PCI Target Abort. When this error occurs, the host controller clears EHCI[3:1]x20[RunStop] to prevent further execution of the scheduled TDs.</p>										
3	<p>FrameListRollover: Frame List Rollover. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=EHCI[3:1]x2C[FrameIndex] rolls over from its maximum value to zero. The exact Frame List Index value at which the rollover occurs depends on the frame list size.</p>										
2	<p>PortChangeDetect: Port Change Detect. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=One of the following port change event has occurred:</p> <ul style="list-style-type: none"> • EHCI[3:1]x[70,6C,68,64][PortOwner] changed from 0 to 1; • EHCI[3:1]x[70,6C,68,64][ForcePortResume] changed from 0 to 1; • EHCI[3:1]x[70,6C,68,64][ConnectStatusChange] is set to 1. 										
1	<p>UsbErrInt: USB Error Interrupt. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=The completion of a USB transaction results in an error condition (e.g., error counter underflow). If the TD on which the error interrupt occurred also had its IOC bit set, both this bit and the UsbInt bit are set.</p>										

0	UsbInt: USB Interrupt. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=A USB transaction has completed, which results in the retirement of a Transfer Descriptor that had its IOC bit set; A short packet is detected (actual number of bytes received was less than the expected number of bytes).
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EHCI[3:1]x28 USB Interrupt Enable

Bits	Description										
31:16	<p>PortNChangeEventEnable: Port-n Change Event Enable. Read-write. Reset: 0. This field is bit significant. Each bit corresponds to a port. For each bit, 1=The host controller issues an interrupt if the corresponding bit in EHCI[3:1]x24[PortNChangeDetect] is set to 1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[PortNChangeDetect]. EHCI[3:1]x04[NPorts] specifies how many ports are exposed by the host controller and thus how many bits in this field are valid.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>Port 1</td></tr> <tr> <td>[1]</td><td>Port 2</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>[15]</td><td>Port 16</td></tr> </table>	Bit	Definition	[0]	Port 1	[1]	Port 2	[15]	Port 16
Bit	Definition										
[0]	Port 1										
[1]	Port 2										
...	...										
[15]	Port 16										
15:6	Reserved.										
5	InterruptOnAsyncAdvanceEn: Interrupt on Async Advance Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt at the next interrupt threshold if EHCI[3:1]x24[InterruptOnAsyncAdvance] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[InterruptOnAsyncAdvance] .										
4	HostSystemErrorEn: Host System Error Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt if EHCI[3:1]x24[HostSystemError] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[HostSystemError] .										
3	FrameListRolloverEn: Frame List Rollover Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt if EHCI[3:1]x24[FrameListRollover] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[FrameListRollover] .										
2	PortChangeIntEn: Port Change Interrupt Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt if EHCI[3:1]x24[PortChangeDetect] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[PortChangeDetect] .										
1	UsbErrIntEn: USB Error Interrupt Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt at the next interrupt threshold if EHCI[3:1]x24[UsbErrInt] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[UsbErrInt] .										
0	UsbIntEn: USB Interrupt Enable. Read-write. Reset: 0. 1=The host controller issues an interrupt at the next interrupt threshold if EHCI[3:1]x24[UsbInt] ==1. The interrupt is acknowledged by software clearing EHCI[3:1]x24[UsbInt] .										

EHCI[3:1]x2C Frame Index

Bits	Description
31:14	Reserved.

13:0	<p>FrameIndex: Frame Index. Read-write; updated-by-hardware. Reset: 0. This register is used by the host controller to index into the periodic frame list. The register updates every 125 microseconds (once each micro-frame). Bits [N:3] are used to select a particular entry in the Periodic Frame List during periodic schedule execution. The number of bits used for the index depends on EHCI[3:1]x20[FrameListSize].</p> <p>This register must be written as a DWord. Byte writes produce undefined results. This register cannot be written unless EHCI[3:1]x24[HCHalted]=1. Writes to this register also affect the SOF value.</p>
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[EHCI\[3:1\]x30 Control Data Structure Segment](#)

Bits	Description
31:0	<p>CtrlDSSegment. IF (EHCI[3:1]x08[AddressingCapability64Bit]==0) THEN RAZ. ELSE Read-write. ENDIF. Reset: 0. Specifies the most significant address bits [63:32] for all EHCI data structures if EHCI[3:1]x08[AddressingCapability64Bit]==1. This register is concatenated with the link pointer from either EHCI[3:1]x34, or EHCI[3:1]x38, or any control data structure link field to construct a 64-bit address.</p>

[EHCI\[3:1\]x34 Periodic Frame List Base Address](#)

Bits	Description
31:12	<p>BaseAddress: Base Address. Read-write. Reset: 0. Specifies the beginning address [31:12] of the Periodic Frame List in the system memory. If (EHCI[3:1]x08[AddressingCapability64Bit]==1), the most significant 32 bits of every control data structure address comes from EHCI[3:1]x30.</p>
11:0	Reserved.

[EHCI\[3:1\]x38 Current Async List Address](#)

Bits	Description
31:5	<p>LPL: Link Pointer Low. Read-write. Reset: 0. Specifies the address [31:5] of the next asynchronous queue head to be executed. If (EHCI[3:1]x08[AddressingCapability64Bit]==1), the most significant 32 bits of every control data structure address comes from EHCI[3:1]x30. This field may only reference a Queue Head (QH).</p>
4:0	Reserved.

[EHCI\[3:1\]x60 Configure Flag](#)

Bits	Description
31:1	Reserved.
0	<p>CF: Configure Flag. Read-only. Reset: 1. This bit controls the default port-routing control logic. Software sets this bit as the last action in its process of configuring the host controller. 0=Port routing control logic default-routes each port to an implementation dependent classic host controller. 1=Port routing control logic default-routes all ports to this host controller.</p>

EHCI[3:1]x[70,6C,68,64] Port Status Control [4:1]

Bits	Description																							
31:25	DeviceAddress: Device Address. Read-write. Reset: 0. Specifies the 7-bit USB device address for the device attached to and immediately downstream of the associated root port. 0=Indicates no device is present or support for this feature is not present.																							
24:23	SuspendStatus: Suspend Status. Read-only; updated-by-hardware. Reset: 0. These two bits are used by software to determine whether the most recent L1 suspend request was successful, specifically: <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>Success: State transition was successful (ACK)</td></tr><tr><td>01b</td><td>Not Yet: Device was unable to enter the L1 state at this time (NYET)</td></tr><tr><td>10b</td><td>Not Supported: Device does not support the L1 state (STALL)</td></tr><tr><td>11b</td><td>Timeout/Error: Device failed to respond or an error occurred.</td></tr></table> This field is updated by hardware immediately following the completion of an L1 transition request (via an LPM Token). To avoid any race conditions with hardware, software should only consume the contents of this field when Suspend==0 (port no longer in L1).				Bits	Definition	00b	Success: State transition was successful (ACK)	01b	Not Yet: Device was unable to enter the L1 state at this time (NYET)	10b	Not Supported: Device does not support the L1 state (STALL)	11b	Timeout/Error: Device failed to respond or an error occurred.										
Bits	Definition																							
00b	Success: State transition was successful (ACK)																							
01b	Not Yet: Device was unable to enter the L1 state at this time (NYET)																							
10b	Not Supported: Device does not support the L1 state (STALL)																							
11b	Timeout/Error: Device failed to respond or an error occurred.																							
22	WakeOnOverCurrentEnable: wake on over-current enable. Read-write. Reset: 0. 1=Enables the port to be sensitive to over-current conditions as wake-up events. This field is 0 if (PortPower==0).																							
21	WakeOnDisconnectEnable: wake on disconnect enable. Read-write. Reset: 0. 1=Enables the port to be sensitive to device disconnects as wake-up events. This field is 0 if (PortPower==0).																							
20	WakeOnConnectEnable: wake on connect enable. Read-write. Reset: 0. 1=Enables the port to be sensitive to device connects as wake-up events. This field is 0 if (PortPower==0).																							
19:16	PortTestControl: Port Test Control. Read-write. Reset: 0. When this field is 0, the port is not operating in a test mode. A non-zero value indicates that it is operating in test mode and the specific test mode is indicated by the specific value. <table><tr><th>Bits</th><th>TestMode</th><th>Bits</th><th>TestMode</th></tr><tr><td>0000b</td><td>Test mode not enabled</td><td>0100b</td><td>Test Packet</td></tr><tr><td>0001b</td><td>Test J_STATE</td><td>0101b</td><td>Test FORCE_ENABLE</td></tr><tr><td>0010b</td><td>Test K_STATE</td><td>1111-0110b</td><td>Reserved</td></tr><tr><td>0011b</td><td>Test SE0_NAK</td><td></td><td></td></tr></table>				Bits	TestMode	Bits	TestMode	0000b	Test mode not enabled	0100b	Test Packet	0001b	Test J_STATE	0101b	Test FORCE_ENABLE	0010b	Test K_STATE	1111-0110b	Reserved	0011b	Test SE0_NAK		
Bits	TestMode	Bits	TestMode																					
0000b	Test mode not enabled	0100b	Test Packet																					
0001b	Test J_STATE	0101b	Test FORCE_ENABLE																					
0010b	Test K_STATE	1111-0110b	Reserved																					
0011b	Test SE0_NAK																							
15:14	PortIndicatorControl: Port Indicator Control. IF (EHCI[3:1]x04[PortIndicators]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. This field is 0 if PortPower==0. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>Port indicators are off.</td><td>10b</td><td>Green</td></tr><tr><td>01b</td><td>Amber</td><td>11b</td><td>Undefined</td></tr></table>				Bits	Definition	Bits	Definition	00b	Port indicators are off.	10b	Green	01b	Amber	11b	Undefined								
Bits	Definition	Bits	Definition																					
00b	Port indicators are off.	10b	Green																					
01b	Amber	11b	Undefined																					
13	PortOwner: Port Owner. Read-only. Reset: 0.																							
12	PortPower: Port Power. IF (EHCI[3:1]x04[PPC]==0) THEN Read-only. ELSE Read-write. ENDIF. IF (EHCI[3:1]x04[PPC]==0) THEN Reset: 1. ELSE Reset: X. ENDIF. 0=Power is off; the port is non-functional and does not report attaches, detaches, etc. 1=Power is on. When an over-current condition is detected on a powered port and EHCI[3:1]x04[PPC]==1, the PortPower bit in each affected port may be transitioned by the host controller from 1 to 0 (removing power from the port).																							

11:10	<p>LineStatus[1:0]: Line Status. Read-only. Reset: X. These bits reflect the current logical levels of the D+ (LineStatus[1]) and D- (LineStatus[0]) signal lines. These bits are used for detection of low-speed USB devices prior to the port reset and enable sequence. This field is valid only when PortEnable==0 and CurrentConnectStatus==1.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>SE0. Not Low-speed device, perform EHCI reset</td></tr> <tr> <td>01b</td><td>K-state. Low-speed device, release ownership of port</td></tr> <tr> <td>10b</td><td>J-state. Not Low-speed device, perform EHCI reset</td></tr> <tr> <td>11b</td><td>Undefined. Not Low-speed device, perform EHCI reset.</td></tr> </table> <p>This value of this field is undefined if (PortPower==0).</p>	<u>Bits</u>	<u>Definition</u>	00b	SE0. Not Low-speed device, perform EHCI reset	01b	K-state. Low-speed device, release ownership of port	10b	J-state. Not Low-speed device, perform EHCI reset	11b	Undefined. Not Low-speed device, perform EHCI reset.
<u>Bits</u>	<u>Definition</u>										
00b	SE0. Not Low-speed device, perform EHCI reset										
01b	K-state. Low-speed device, release ownership of port										
10b	J-state. Not Low-speed device, perform EHCI reset										
11b	Undefined. Not Low-speed device, perform EHCI reset.										
9	<p>SuspendUsingL1: Suspend using L1. Read-write. Reset: 0. 0=The host controller employs the legacy (L2) suspend mechanism. 1=If a non-zero value is specified in DeviceAddress, the host controller generates an LPM Token to enter the L1 state whenever software writes a 1 to the Suspend bit, as well as L1 exit timing during any device- or host-initiated resume.</p> <p>Software should only set this bit when the device attached immediately downstream of this root port supports L1 transitions.</p>										
8	<p>PortReset: Port Reset. Read-write. Reset: 0. 1=Port is in Reset. 0=Port is not in Reset. Software writes 1 to start the bus reset sequence; It must keep this bit at a 1 long enough to ensure the reset sequence completes. Software writes 0 to terminate the bus reset sequence; This bit does not read as a 0 until after the reset has completed.</p> <p>When software writes this bit to a 1, it must also write a 0 to the PortEnable bit. If the port is in high-speed mode after reset is complete, the host controller automatically enables this port (e.g. set the Port Enable bit to a 1). EHCI[3:1]x24[HCHalted] should be a 0 before software attempts to use this bit. The host controller may hold Port Reset asserted to a 1 when the HCHalted bit is a 1. This field is 0 if PortPower==0.</p>										
7	<p>Suspend. Read; cleared-by-hardware; write-1-only. Reset: 0. 0=IF (EHCI[3:1]x[70,6C,68,64][PortEnable] == 1) THEN Port is enabled. ELSE Port is disabled. ENDIF. 1=IF (EHCI[3:1]x[70,6C,68,64][PortEnable] == 1) THEN Port is in suspend state; The port can be in either L1 or L2 suspend state depending on SuspendUsingL1. ELSE Port is disabled. ENDIF.</p> <p>When in suspend state, downstream propagation of data is blocked on this port, except for port reset. If this bit is written with a 1 when a transaction is in progress then the blocking does not occur until the end of the current transaction. In the suspend state, the port is sensitive to resume detection. Additional status for L1-based transitions is provided to software via the SuspendStatus field. This field is 0 if PortPower==0. If system software sets this bit to a 1 when the port is not enabled (i.e. PortEnable == 0) the results are undefined. A write of 0 to this bit is ignored by the host controller. The host controller is unconditionally set this bit to a 0 when:</p> <ul style="list-style-type: none"> • Software sets the ForcePortResume bit to a 0 from a 1. • Software sets the PortReset bit to a 1 from a 0. • Whenever PortPower is zero. 										

6	<p>ForcePortResume: Force Port Resume. Read-write; set-by-hardware. Reset: 0. 1=Resume detected/driven on port. 0=No resume (K-state) detected/driven on port. This field is 0 if PortPower==0.</p> <p>This functionality defined for manipulating this bit depends on the value of the Suspend and SuspendUsingL1 bits. For example, if the port is not suspended (Suspend and Enabled bits are a 1) and software transitions this bit to a 1, then the effects on the bus are undefined.</p> <p>The Host Controller sets this bit to a 1 if a J-to-K transition is detected while the port is in the Suspend state. In this case, EHCI[3:1]x24[PortChangeDetect] and/or EHCI[3:1]x24[PortNChangeDetect] is also be set to 1.</p> <p>Software sets this bit to a 1 to drive resume signaling. If software sets this bit to a 1, the host controller must not set EHCI[3:1]x24[PortChangeDetect] and/or EHCI[3:1]x24[PortNChangeDetect]. Writing a 0 (from 1) causes the port to return to high-speed mode. This bit remains a 1 until the port has switched to the high-speed idle. The host controller must complete this transition within 2 milliseconds of software setting this bit to a 0.</p> <p>For legacy (L2) transitions, software must appropriately time the Resume and set this bit to a 0 when the appropriate amount of time has elapsed. Software does not need to time resume signaling for L1 transactions as host controller hardware automatically enforces the necessary timing and clear this bit when the port has fully resumed. Software can influence the amount of time hardware drives resume signaling during L1 exit via EHCI[3:1]x20[HostInitiatedResumeDuration].</p>
5	<p>OverCurrentChange: over-current change. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=There is a change to OverCurrentActive.</p>
4	<p>OverCurrentActive: over-current active. Read-only; updated-by-hardware. Reset: 0. 1=This port currently has an over-current condition. 0=This port does not have an over-current condition.</p>
3	<p>PortEnableDisableChange: Port Enable/Disable Change. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Port enabled/disabled status has changed. 0=No change. For the root hub, this bit gets set to a 1 only when a port is disabled due to the appropriate conditions existing at the EOF2. This field is 0 if PortPower==0.</p>
2	<p>PortEnable: port enable. Read-write; set-by-hardware. Reset: 0. 1=Enable. 0=Disable.</p> <p>Ports can only be enabled by the host controller as a part of the reset and enable. Software cannot enable a port by writing a 1 to this field. The host controller only sets this bit to a 1 when the reset sequence determines that the attached device is a high-speed device.</p> <p>Ports can be disabled by either a fault condition (disconnect event or other fault condition) or by host software. The bit status does not change until the port state actually changes. There may be a delay in disabling or enabling a port due to other host controller and bus events. When the port is disabled, downstream propagation of data is blocked on this port, except for reset. This field is 0 if PortPower==0.</p>
1	<p>ConnectStatusChange: Connect Status Change. Read; set-by-hardware; write-1-to-clear. Reset: 0. Indicates a change has occurred in the port's CurrentConnectStatus. The host controller sets this bit for all changes to the port device connect status, even if system software has not cleared an existing connect status change. This field is 0 if PortPower==0. 1=Change in Current Connect Status. 0=No change.</p>
0	<p>CurrentConnectStatus: Current Connect Status. Read-only. Reset: 0. This value reflects the current state of the port, and may not correspond directly to the event that caused the ConnectStatusChange to be set to 1. This field is 0 if PortPower==0. 1=Device is present on port. 0=No device is present.</p>

EHCI[3:1]xA4 Packet Buffer Threshold Values

BIOS: 0040_0040h.

Bits	Description
31:24	Reserved.
23:16	OUTThreshold: OUT Threshold. Read-write. Reset: 40h. The transmit packet starts at UTMI interface when threshold of internal FIFO for transmit packet is reached. The value represents multiple of 8 bytes. For example, 10h means 128 bytes. The smallest acceptable value is 08h (64 bytes).
15:8	Reserved.
7:0	INThreshold: IN Threshold. Read-write. Reset: 40h. The PCI transaction starts when threshold of internal FIFO for receive packet is reached. The value represents multiple of 8 bytes. For example, 10h means 128 bytes. The smallest acceptable value is 08h (64 bytes).

EHCI[3:1]xB4 UTMI Control

BIOS: See [2.17.2.5](#) & [2.17.2.7](#).

Bits	Description																												
31:18	Reserved.																												
17	VBusy. Read-only. Reset: 0. 1=Block software writes to bits[16:8] when port router is updating the field.																												
16:13	PortNumber: Port Number. Read-write. Reset: 0. Select the corresponding port PHY or common block to load the VControl bits. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0000b</td><td>Port 0</td><td>0011b</td><td>Port 3</td></tr><tr><td>0001b</td><td>Port 1</td><td>1110b-0100b</td><td>Reserved</td></tr><tr><td>0010b</td><td>Port 2</td><td>1111b</td><td>Common block</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	0000b	Port 0	0011b	Port 3	0001b	Port 1	1110b-0100b	Reserved	0010b	Port 2	1111b	Common block												
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																										
0000b	Port 0	0011b	Port 3																										
0001b	Port 1	1110b-0100b	Reserved																										
0010b	Port 2	1111b	Common block																										
12	VLoadB. Read-write. Reset: 1. VControl value load, active low. 0=Load the new VControl value to the PHY or common block specified by PortNumber. VLoadB must be 1 while VControlModeSel is changed.																												
11	Reserved.																												
10:7	VControlModeSel. Read-write. Reset: 0. Selects the PHY control mode group. There are 8 groups defined for PHY control mode. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0000b</td><td>Group 0</td><td>0110b</td><td>Group 6. Analog Control</td></tr><tr><td>0001b</td><td>Group 1</td><td>0111b</td><td>Group 7</td></tr><tr><td>0010b</td><td>Group 2</td><td>1000b</td><td>Group 8</td></tr><tr><td>0011b</td><td>Group 3</td><td>1001b</td><td>Group 9</td></tr><tr><td>0100b</td><td>Group 4. CDR DFT control</td><td>1111b-1010b</td><td>Reserved</td></tr><tr><td>0101b</td><td>Group 5. CDR DFT control</td><td></td><td></td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	0000b	Group 0	0110b	Group 6. Analog Control	0001b	Group 1	0111b	Group 7	0010b	Group 2	1000b	Group 8	0011b	Group 3	1001b	Group 9	0100b	Group 4. CDR DFT control	1111b-1010b	Reserved	0101b	Group 5. CDR DFT control		
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																										
0000b	Group 0	0110b	Group 6. Analog Control																										
0001b	Group 1	0111b	Group 7																										
0010b	Group 2	1000b	Group 8																										
0011b	Group 3	1001b	Group 9																										
0100b	Group 4. CDR DFT control	1111b-1010b	Reserved																										
0101b	Group 5. CDR DFT control																												
6:0	Reserved.																												

EHCI[3:1]xB8 Loopback Test

Bits	Description
31:27	Reserved.

26:21	StatusOfPortsforPowerUpStateCheck[5:0]: Status of ports for PowerUp State Check. Read-only. Reset: 0. Status bit to indicate the Power Up state auto-checking result from the individual port. Each bit maps to a corresponding port, from port 0 to port 5. <table><tr><td><u>Bit</u></td><td><u>Definition</u></td><td><u>Bit</u></td><td><u>Definition</u></td></tr><tr><td>[0]</td><td>Port 0</td><td>[3]</td><td>Port 3</td></tr><tr><td>[1]</td><td>Port 1</td><td>[4]</td><td>Port 4</td></tr><tr><td>[2]</td><td>Port 2</td><td>[5]</td><td>Port 5</td></tr></table> For each bit, 0=PHY Power Up State checking is fail. 1=PHY Power Up State checking is good.	<u>Bit</u>	<u>Definition</u>	<u>Bit</u>	<u>Definition</u>	[0]	Port 0	[3]	Port 3	[1]	Port 1	[4]	Port 4	[2]	Port 2	[5]	Port 5
<u>Bit</u>	<u>Definition</u>	<u>Bit</u>	<u>Definition</u>														
[0]	Port 0	[3]	Port 3														
[1]	Port 1	[4]	Port 4														
[2]	Port 2	[5]	Port 5														
20	EnablePHYPowerUpStateChecking: Enable PHY PowerUp State Checking. Read-write. Reset: 0. 1=Enable auto-checking on PHY Power Up State. There is built-in logic to check the PHY default Power Up state to detect manufacturing defects in the PHY macro.																
19:12	GoodReceivedPacketCount: Good Received Packet Count. Read-only; updated-by-hardware. Reset: 0. Specified the number of good packets that the host controller received during the loopback test mode. These bits are cleared by clearing EnableLoopBackTest.																
11	Reserved.																
10	LoopbackTestDone: Loopback Test Done. Read-only. Reset: 0. 1=Loopback test is done.																
9	LoopbackTestStatus: Loopback Test Status. Read-only. Reset: 0. 0=CRC error on loopback receiving data. 1=Good CRC on loopback receiving data.																
8	EnableLoopBackTest: Enable Loop Back Test. Read-write. Reset: 0. 1=Enable external USB port loopback test. The loopback test is to set one port to TX mode (Test Packet mode) and one port to RX mode (Test SE0_NAK). See EHCI[3:1]x[70,6C,68,64][PortTestControl] for information on the tests.																
7:4	Reserved.																
3:0	ReceivedPacketCount: Received Packet Count. Read-write. Reset: 0. RX data packet count. This counter defines the number (in power of 16) of RX data packet that should be checked for the loop back test.																

EHCI[3:1]xBC EOR MISC Control

Bits	Description
31:24	ForceTxData[7:0]: Force TX Data [7:0]. Read-write. Reset: 0. Used to force TxData[7:0] when the port is in TEST_K mode. This can be used to force PHY to generate a desired output pattern for PHY debugging and characterization purposes.
23:15	Reserved.
14	EHCIDeepBlinkPowerSavingEnable: EHCI Deep Blink Power Saving Enable. Read-write. Reset: 1. 1=Enable Deep Blink power saving clock gating; EHCI requests to stop the Global Blink clock when the list processor is idle.
13	Reserved.
12	EHCIPowerSavingEnable: EHCI Power Saving Enable. Read-write. Reset: 1. 1=Enable power saving clock gating. When enabled, dynamic clock gating is enabled when EHCI is not in operational mode. The clock going to all memory modules are gated off. Blink clock also gets gated off unless the connection interrupt is detected.
11	DisablesHSuFrameBabbleDetection: Disables HS uFrame Babble detection. Read-write. Reset: 0. 1=Disable HS uFrame babble detection.
10:8	Reserved.

7:4	InterPacketGapAdjustCounter: Inter-packet Gap Adjust Counter. Read-write. Reset: 4h. Specifies the counter used to adjust the inter-packet gap for test packet.
3:2	Reserved.
1	InterruptrouteControlonForcePortResume: Interrupt route Control on ForcePortResume. Read-write. Reset: 0. This bit only takes effect when the EnableInterruptOnForcePortResume=1. 0=Report interrupt to EHCI[3:1]x24[UsbInt] bit on software clear EHCI[3:1]x[70,6C,68,64][ForcePortResume] . 1=Report interrupt to EHCI[3:1]x24[PortChangeDetect] bit on software clear EHCI[3:1]x[70,6C,68,64][ForcePortResume] .
0	EnableInterruptonForcePortResume: Enable Interrupt on ForcePortResume. Read-write. Reset: 0. 1=Enable host controller to generate interrupt on software clear EHCI[3:1]x[70,6C,68,64][ForcePortResume] .

EHCI[3:1]xC0 USB Common PHY CAL and Control

Bits	Description
31	Reserved.
30:24	CommonPhyCalBus. Read-only; updated-by-hardware. Reset: X. PHY Common Calibration Bus.
23	Reserved.
22:20	ComCalAmp. Read-only; updated-by-hardware. Reset: X. Specifies the amplitude calibration data from PHY.
19:18	Reserved.
17	AddToCommonCalibration. Read-write. Reset: 1. BIOS: See 2.17.2.6 . 1=The signed NewCalBus is added to the ComCalBus and returned to the PHY ports; Any overflow is clamped to all 1s; Any underflow is clamped to all 0s. 0=The signed NewCalBus replaces the ComCalBus and returns to the PHY ports if UseCommonCalibration=0.
16	UseCommonCalibration. Read-write. Reset: 0. BIOS: See 2.17.2.6 . 1=The PHY's calibration value in ComCalBus is returned to the PHY ports. 0=The value after adjustment is returned to the PHY ports.
15:8	NewCalBus[7:0]. Read-write. Reset: 0. BIOS: See 2.17.2.6 . New calibration bus signed value.
7	Reserved.
6:0	ComCalBus. Read-only; updated-by-hardware. Reset: X. Calibration bus value from PHY before adjustment.

EHCI[3:1]xC4 USB Common PHY Control 1

BIOS: See [2.17.2.5](#).

Bits	Description										
31:24	DLLControl: DLL Control. Read-write. Reset: A0h. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[1:0]</td><td>Reserved.</td></tr> <tr> <td>[2]</td><td>DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.</td></tr> <tr> <td>[5:3]</td><td>DLL_cpump. DLL charge pump current control.</td></tr> <tr> <td>[7:6]</td><td>DLL_VtoI. DLL gain control.</td></tr> </table>	Bit	Definition	[1:0]	Reserved.	[2]	DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.	[5:3]	DLL_cpump. DLL charge pump current control.	[7:6]	DLL_VtoI. DLL gain control.
Bit	Definition										
[1:0]	Reserved.										
[2]	DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.										
[5:3]	DLL_cpump. DLL charge pump current control.										
[7:6]	DLL_VtoI. DLL gain control.										
23:21	Reserved.										

20	PLLBypass: PLL Bypass. Read-write. Reset: 0. 1=Enable USB Common PLL bypass.
19:16	DutyAdj. Read-write. Reset: 4h. Specifies CLK480 duty cycle control from 40-60% to 60-40%.
15:12	PVI. Read-write. Reset: 2h. Specifies PLL V-I Converter Control for common block PLL.
11:8	IRefAdj. Read-write. Reset: 1. Specifies internal reference bias adjustment for common block.
7:4	XRefAdj. Read-write. Reset: 1. Specifies external reference bias adjustment for common block.
3:0	CPAdj. Read-write. Reset: 4h. Charge pump setting for common block PLL.

EHCI[3:1]xD0 USB Common PHY Control 2

Bits	Description
31:16	Reserved.
15	BgBypass. Read-write. Reset: 0. Bandgap bypass.
14	Reserved.
13:12	PLLLockAdj[1:0]. Read-write. Reset: 0. PLL lock detection tuning.
11	UnlockSticky. Read-only. Reset: X. Sticky unlock detection observability.
10	UnlockReset. Read-write. Reset: 0. Reset sticky un-lock detector.
9	LockDetect. Read-only. Reset: X. Lock detection observability.
8	EnLockDetect. Read-write. Reset: 0. Enable PLL lock detection.
7:4	CBackup. Read-write. Reset: 0h. Common block backup.
3:0	BgAdj. Read-write. Reset: 6. BIOS: See 2.17.2.5 . Bandgap voltage adjust.

EHCI[3:1]xD4 USB Common PHY Control 3

BIOS: See [2.17.2.5](#).

Bits	Description
31:8	Reserved.
7:6	PIIFilter. Read-write. Reset: 0. PLL Filter tuning setting.
5:4	PIIDiv. Read-write. Reset: 0. PLL divider setting.
3:2	PIIReg. Read-write. Reset: 0. PLL Regulator tuning setting.
1	CalEnable. Read-write. Reset: 0. Calibration Enable.
0	BgStart. Read-write. Reset: 0. Bandgap startup tuning setting.

EHCI[3:1]xDC USB Battery Charger Enable

Bits	Description
31:4	Reserved.
3:0	UsbBatteryChargerEnable. Read-write. Reset: 0. One bit controls one respective port. For each bit, 1=Enable USB PHY battery charger function for the port.

3.26.4.2 USB 3.0 (xHCI)

The xHCI controller has a PCI configuration register space. The PCI configuration register space uses device 10h function 0 and is defined below as D10F0xXX.

3.26.4.2.1 Device 10h Function 0 (xHCI) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D10F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: Device ID. Read-only. Reset: 7814h. Device Identifier.
15:0	VendorID: Vendor ID. Read-only. Reset: 1022h. Vendor Identifier.

D10F0x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; set-by-hardware; write-1-to-clear. Reset: 0.
30	SignaledSystemError: Signaled System Error. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=System error signaled via SERR#.
29	ReceivedMasterAbort: Received Master Abort. Read; set-by-hardware; write-1-to-clear. Reset: 0.
28	ReceivedTargetAbort: Received Target Abort. Read; set-by-hardware; write-1-to-clear. Reset: 0.
27	SignaledTargetAbort: Signaled Target Abort. Read; set-by-hardware; write-1-to-clear. Reset: 0.
26:25	DEVSELTiming: DEVSEL Timing. Value: 0.
24	MasterDataParityError: Master Data Parity Error. Read; set-by-hardware; write-1-to-clear. Reset: 0.
23	FastBack2BackCapable: Fast Back-to-Back Capable. Value: 0.
22	Reserved.
21	Capable66MHz: 66 MHz Capable. Value: 0.
20	CapabilitiesList: Capabilities List. Value: 1. 1=Indicates that the value read at offset 34h is a pointer in Configuration Space to a linked list of new capabilities.
19	InterruptStatus: Interrupt Status. Read-only. Reset: 0. 1=An INTx interrupt message is pending in the device.
18:11	Reserved.
10	InterruptDisable: Interrupt Disable. Read-only. Reset: 0. 0=Enable the assertion of the device/function's INTx# signal. 1=Disable the assertion of the device/function's INTx# signal.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Value: 0. 0=Only fast back-to-back transactions to the same agent are allowed.
8	SERREnable: SERR# Enable. Read-write. Reset: 0. 1=System error reporting enabled.
7	RAZ.

6	ParityEnable: Parity Enable. Read-write. Reset: 0. 0=The device sets its DetectedParityError when an error is detected, but continues normal operations without asserting PERR#. 1=The device must take its normal action when a parity error is detected.
5	VgaPaletteRegisterAccesses: VGA palette register accesses. Value: 0. 0=The device should treat palette write accesses like all other accesses.
4	MemoryWriteandInvalidateCommand: Memory Write and Invalidate Command. Value: 0. 0=Memory Write must be used.
3	SpecialCycle: Special Cycle. Value: 0. 0=No Special Cycle support.
2	BusMaster: Bus Master. Read-write. Reset: 0. 0=Disable the device from generating PCI accesses. 1=Allow the device to behave as a bus master.
1	MemorySpaceAccesses: Memory Space Accesses. Read-write. Reset: 0. 0=Disable the device response. 1=Allow the device to respond to Memory Space accesses.
0	IOspaceAccesses: IO Space Accesses. Value: 0. 0=IO accesses targeting this device are not accepted.

D10F0x08 Revision ID / Class Code

Bits	Description
31:24	BaseClass: Base Class. Read-only. Reset: Ch. Base Class. Serial Bus Controller.
23:16	SubClass: Sub Class. Read-only. Reset: 3h. Sub Class. Universal Serial Bus Host Controller.
15:8	ProgrammingInterface: Programming Interface. Read-only. Reset: 30h. Programming Interface. USB 3.0 Host Controller that conforms to xHC specification.
7:0	RevisionID. Read-only. Reset: 01h.

D10F0x0C Miscellaneous

Bits	Description
31:24	Bist. Value: 0. 00h=BIST is not supported.
23:16	HeaderType: Header Type. Value: 00h. 00h=The device does not have multiple functions.
15:8	LatencyTimer: Latency Timer. Value: 0.
7:0	CacheLineSize: Cache Line Size. Read-write. Reset: 0. This read/write field specifies the system cache line size in units of doublewords and must be initialized to 00h.

D10F0x10 Bar 0

Bits	Description
31:13	Bar0. Read-write. Reset: 0. Specifies Base Address [31:13].
12:4	Reserved.
3	PM: Prefetch memory. Value: 0. 0=Indicates that there is no support for prefetchable memory.
2:1	Tp: Type. Value: 10b. 10b=64 bit address.
0	Ind: Indicator. Value: 0. 0=Indicates that the operational registers of the device are mapped into memory space of the main memory of the PC host system.

D10F0x14 Bar 1

Bits	Description
31:0	Bar1: Base Address High. Read-write. Reset: 0. Specifies Base Address [63:32].

D10F0x2C Subsystem Vendor ID / Subsystem ID

Bits	Description
31:16	SubsystemID: Subsystem ID. Read-only. Reset: 7814h. Subsystem ID.
15:0	SubsystemVendorID: Subsystem Vendor ID. Read-only. Reset: 1022h. Subsystem Vendor ID.

D10F0x34 Capability Pointer

Bits	Description
7:0	CapabilityPointer: Capability Pointer. Read-only. Reset: 50h. Address of the 1st element of capability link.

D10F0x3C Interrupt Line

Bits	Description
31:16	Reserved.
15:8	InterruptPin: Interrupt Pin. Read-only. Reset: 1. Specifies which interrupt pin the device (or device function) uses. A value of 1 corresponds to INTA#.
7:0	InterruptLine: Interrupt Line. Read-write. Reset: 0. Specifies which input of the system interrupt controller(s) the device's interrupt pin is connected to. The device itself does not use this value; rather it is used by device drivers and operating systems to determine priority and vector information.

D10F0x40 IDP Index Register

Bits	Description
31:13	Reserved.
12:2	IDPIndex: IDP Index. Read-only. Reset: 0. This register selects the doubleword offset of the memory mapped register to be accessed. All register accesses are at doubleword granularity.
1:0	Reserved.

D10F0x44 IDP Data Register

Bits	Description
31:0	IDPData: IDP Data. Read-only. Reset: 0. Specifies the data read from or written to the memory mapped register pointed to by D10F0x40 . A physical register is not actually implemented as the data is actually stored in the memory mapped registers. The default value is the same as the default value of the register pointed to by D10F0x40 .

D10F0x48 Indirect PCI Index Register

Bits	Description												
31:30	IndirectPCIIndex[31:30]: Indirect PCI Index. Read-write. Reset: 0. Selects the PCI indirect space. This field is combined with IndirectPCIIndex[15:2] to select the PCI indirect register to be accessed. <ul style="list-style-type: none">IndirectPCIIndex[31:0] range for 3.26.4.2.1.1 [USB 3.0 125 MHz PCI Indirect Space]: 0000_FFFFh-0000_0000h.IndirectPCIIndex[31:0] range for 3.26.4.2.1.2 [USB 3.0 60 MHz PCI Indirect Space]: 4000_FFFFh-4000_0000h. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>Selects 125 MHz PCI indirect space</td><td>10b</td><td>Reserved</td></tr><tr><td>01b</td><td>Selects 60 MHz PCI indirect space</td><td>11b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	Selects 125 MHz PCI indirect space	10b	Reserved	01b	Selects 60 MHz PCI indirect space	11b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	Selects 125 MHz PCI indirect space	10b	Reserved										
01b	Selects 60 MHz PCI indirect space	11b	Reserved										
29:16	Reserved.												
15:2	IndirectPCIIndex[15:2]: Indirect PCI Index. Read-write. Reset: 0. Selects the doubleword offset of the PCI indirect space register to be accessed. All register accesses are at doubleword granularity.												
1:0	Reserved.												

D10F0x4C Indirect PCI Data Register

Bits	Description
31:0	IndirectPCIData: Indirect PCI Data. Read-write. Reset: 0. Specifies the data written to/read from the PCI indirect space register pointed to by D10F0x48 . A physical register is not actually implemented as the data is actually stored in the PCI indirect space registers. The default value is the same as the default value of the register pointed to by D10F0x48 .

3.26.4.2.1.1 USB 3.0 125 MHz PCI Indirect Space

These registers are indirectly accessed through [D10F0x48](#) and [D10F0x4C](#).

D10F0x4C_x08 Port Disable Write Once

Bits	Description
------	-------------

31:4	Reserved.						
3:0	<p>XhcPortDisableWriteOnce: xHC Port Disable Write Once. Read; write-once; write-1-only. Reset: 0. This field is bit significant. Once written, the register can only be cleared by PciRst#. For each bit, 1=Disable the corresponding port.</p> <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>port 0</td></tr> <tr> <td>[1]</td><td>port 1</td></tr> </table> <p>If (D10F0x4C_x08[XhcPortDisableWriteOnce] D10F0x4C_x0C[XhcPortDisableRW]), then the corresponding xHC port is disabled.</p>	<u>Bit</u>	<u>Definition</u>	[0]	port 0	[1]	port 1
<u>Bit</u>	<u>Definition</u>						
[0]	port 0						
[1]	port 1						

D10F0x4C_x0C Port Disable RW

Bits	Description						
31:4	Reserved.						
3:0	<p>XhcPortDisableRW: xHC Port Disable RW. Read-write. Reset: 0. This field is bit significant. For each bit, 1=The corresponding port is disabled.</p> <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>port 0</td></tr> <tr> <td>[1]</td><td>port 1</td></tr> </table> <p>If (D10F0x4C_x08[XhcPortDisableWriteOnce] D10F0x4C_x0C[XhcPortDisableRW]), then the corresponding xHC port is disabled.</p>	<u>Bit</u>	<u>Definition</u>	[0]	port 0	[1]	port 1
<u>Bit</u>	<u>Definition</u>						
[0]	port 0						
[1]	port 1						

D10F0x4C_x10 USB DCLK Event Counter 0

Bits	Description
31:0	UsbDclkEventCnt0Lo. Read-only. Reset: 0. USB DClk Event Counter 0[31:0].

D10F0x4C_x14 USB DCLK Event Counter 1

Bits	Description
31:0	UsbDclkEventCnt1Lo. Read-only. Reset: 0. USB DClk Event Counter 1[31:0].

D10F0x4C_x18 USB DCLK Event Counter Select

Bits	Description
31:24	UsbDclkEventCnt1Hi. Read-only. Reset: 0. USB DClk Event Counter 1[39:32].
23:16	UsbDclkEventCnt0Hi. Read-only. Reset: 0. USB DClk Event Counter 0[39:32].
15:8	UsbDclkEventSel1. Read-write. Reset: 0. Select the event to be counted by Usb DClk Event Counter 1.
7:0	UsbDclkEventSel0. Read-write. Reset: 0. Select the event to be counted by Usb DClk Event Counter 0.

D10F0x4C_x1C USB DCLK Event Counter Control

Bits	Description
31:3	Reserved.
2	UsbDclkEventCntShadow . Read-write. Reset: 0. Transfer USB DCLK event counter to shadow register.
1	UsbDclkEventCntReseth . Read-write. Reset: 1. Active low reset for USB DCLK event counters.
0	UsbDclkEventCntEn . Read-write. Reset: 0. 1=Enable USB DCLK event counters.

3.26.4.2.1.2 USB 3.0 60 MHz PCI Indirect Space

These registers are accessed through [D10F0x48](#) and [D10F0x4C](#).

D10F0x4C_x4000_0000 UTMI Control

Bits	Description												
31:18	Reserved.												
17	VBusy . Read-only. Reset: 0.												
16:13	PortNumber: Port Number . Read-write. Reset: 0. Selects the corresponding port PHY or common block to load the VControl bits. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0000b</td><td>Port 0</td><td>1110b-0010b</td><td>Reserved</td></tr><tr><td>0001b</td><td>Port 1</td><td>1111b</td><td>Common block</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	0000b	Port 0	1110b-0010b	Reserved	0001b	Port 1	1111b	Common block
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
0000b	Port 0	1110b-0010b	Reserved										
0001b	Port 1	1111b	Common block										
12	VLoadB . Read-write. Reset: 1. Update PHY control mode (active low). 0=Load the new VControl value to PHY/common block. 1=Only load VControlModeSel value to PHY to select different PHY status group (see D10F0x4C_x4000_0004); VControl[6:0] value inside PHY won't get affected.												
11	Reserved.												
10:7	VControlModeSel . Read-write. Reset: 0. Selects the PHY control mode group. See: EHCI[3:1]xB4[VControlModeSel] .												
6:0	VControl . Read-write. Reset: 24h. Controls PHY setting.												

D10F0x4C_x4000_0004 USB PHY Status

Bits	Description
31:16	Reserved.
15:8	Port1PhyStatus . Read-only; updated-by-hardware. Reset: 21h. Specifies the PHY Status of Port 1. Use the D10F0x4C_x4000_0000[VControlModeSel] to select which group's status should be read back.
7:0	Port0PhyStatus . Read-only; updated-by-hardware. Reset: 21h. PHY Status of Port 0. Use the D10F0x4C_x4000_0000[VControlModeSel] to select which group's status should be read back.

D10F0x4C_x4000_0008 USB Common PHY Calibration and Control

Bits	Description
31	Reserved.
30:24	CommonPhyCalBus . Read-only; updated-by-hardware. Reset: X. Specifies PHY common calibration bus.
23	Reserved.
22:20	ComCalAmp . Read-only; updated-by-hardware. Reset: X. Specifies the amplitude calibration data from PHY.
19:18	Reserved.
17	AddToCommonCalibration . Read-write. Reset: 1. BIOS: See 2.22.2.12. 1=The signed NewCalBus is added to the ComCalBus and returned to the PHY ports; Any overflow is clamped to all 1s; Any underflow is clamped to all 0s. 0=The signed NewCalBus replaces ComCalBus and returns to the PHY ports.
16	UseCommonCalibration . Read-write. Reset: 0. BIOS: See 2.22.2.12. 1=The PHY's calibration value in ComCalBus is returned to the PHY ports. 0=The value after adjustment is returned to the PHY ports.
15:8	NewCalBus[7:0] . Read-write. Reset: 0. BIOS: See 2.22.2.12. Specifies the new calibration bus signed value.
7	Reserved.
6:0	ComCalBus . Read-only; updated-by-hardware. Reset: X. Specifies the common calibration bus value from PHY before adjustment.

D10F0x4C_x4000_000C USB Common PHY Control

BIOS: See 2.17.2.8 [xHC USB2.0 Common PHY Calibration].

Bits	Description										
31:24	DllControl: DLL Control . Read-write. Reset: A0h. Specifies USB PHY DLL control. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[1:0]</td><td>Reserved.</td></tr> <tr> <td>[2]</td><td>DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.</td></tr> <tr> <td>[5:3]</td><td>DLL_cpump. DLL charge pump current control.</td></tr> <tr> <td>[7:6]</td><td>DLL_VtoI. DLL gain control.</td></tr> </table>	Bit	Definition	[1:0]	Reserved.	[2]	DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.	[5:3]	DLL_cpump. DLL charge pump current control.	[7:6]	DLL_VtoI. DLL gain control.
Bit	Definition										
[1:0]	Reserved.										
[2]	DLL_EN_PFDphases. 1=Enable DLL phase-sampling based lock detection.										
[5:3]	DLL_cpump. DLL charge pump current control.										
[7:6]	DLL_VtoI. DLL gain control.										
23:21	Reserved.										
20	PllBypass: PLL Bypass . Read-write. Reset: 0. 1=Enable USB Common PLL bypass.										
19:16	DutyAdj . Read-write. Reset: 4h. Specifies CLK480 duty cycle control from 40-60% to 60-40%.										
15:12	PVI . Read-write. Reset: 2h. Specifies PLL V-I converter control for common block PLL.										
11:8	IRefAdj . Read-write. Reset: 1. Specifies internal reference bias adjustment for common block.										
7:4	XRefAdj . Read-write. Reset: 1. Specifies external reference bias adjustment for common block.										
3:0	CPAdj . Read-write. Reset: 4h. Specifies charge pump setting for common block PLL.										

D10F0x4C_x4000_0010 HS Loopback Test

Bits	Description						
31:23	Reserved.						
22:21	StatusOfPowerUpStateCheck: Status of ports for PowerUp State Check. Read-only; updated-by-hardware. Reset: 0. This field is bit-significant. It indicates the Power Up state auto-checking result from the individual port. For each bit, 0=PHY Power Up State checking failed. 1=PHY Power Up State checking is good. <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>Port 0</td></tr> <tr> <td>[1]</td><td>Port 1</td></tr> </table>	<u>Bit</u>	<u>Definition</u>	[0]	Port 0	[1]	Port 1
<u>Bit</u>	<u>Definition</u>						
[0]	Port 0						
[1]	Port 1						
20	EnablePHYPowerUpStateChecking. Read-write. Reset: 0. 1=Enable auto-checking on PHY Power Up State. There is built-in logic to check the PHY default Power Up state to detect manufacturing defects in the PHY macro.						
19:12	GoodReceivedPacketCount. Read-only; updated-by-hardware. Reset: 0. Specifies the number of good packets that the host controller received during the loopback test mode. These bits are cleared by programming EnableLoopBackTest=0.						
11	Reserved.						
10	LoopbackTestDone. Read-only. Reset: 0. 1=Loopback test is done.						
9	LoopbackTestStatus. Read-only. Reset: 0. 0=CRC error on loopback receiving data. 1=Good CRC on loopback receiving data.						
8	EnableLoopBackTest. Read-write. Reset: 0. 1=Enable external USB port loopback test. The loopback test is to set one port to TX mode (Test Packet mode) and one port to RX mode (Test SE0_NAK). See EHCI[3:1]x[70,6C,68,64][PortTestControl] for information on the tests.						
7:4	Reserved.						
3:0	RxPktCnt: Received Packet Count. Read-write. Reset: 0. This counter defines the number (in power of 16) of RX data packets that should be checked for the loop back test.						

D10F0x4C_x4000_0014 CL Loopback Control

Bits	Description								
31	LoopBackTestDone. Read-only; updated-by-hardware. Reset: 0. Host controller sets the bit when loop back is done. The bit is cleared when software clears the LoopBackTestStart bit. 1=Loopback test is done.								
30:16	LoopBackTestStatus. Read-only; updated-by-hardware. Reset: 0. This field is bit-significant. It specifies the loopback test status for the port under test. Software can only check these status bits when the LoopBackTestDone bit is set by the host controller. These bits can only be cleared when software clears the LoopBackTestStart bit. For each bit, 0=Fail. 1=Pass. <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>Port 0</td></tr> <tr> <td>[1]</td><td>Port 1</td></tr> <tr> <td>[4:2]</td><td>Reserved</td></tr> </table>	<u>Bit</u>	<u>Definition</u>	[0]	Port 0	[1]	Port 1	[4:2]	Reserved
<u>Bit</u>	<u>Definition</u>								
[0]	Port 0								
[1]	Port 1								
[4:2]	Reserved								
15:8	LoopBackTestData. Read-write. Reset: 0. Specifies the 1-byte test data pattern for transmit; receive logic checks the received data to match with this data pattern.								

7:4	PortUnderTest . Read-write. Reset: 0. Software selects the port under test through these bits. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0001b-0000b</td><td>Port number <PortUnderTest></td></tr> <tr> <td>1111b-0010b</td><td>Reserved</td></tr> </table>	Bits	Definition	0001b-0000b	Port number <PortUnderTest>	1111b-0010b	Reserved
Bits	Definition						
0001b-0000b	Port number <PortUnderTest>						
1111b-0010b	Reserved						
3:1	Reserved.						
0	LoopBackTestStart . Read-write. Reset: 0. Software sets this bit to start the loopback test and clears this bit to clear out all the test status before starting the next loop. 1=Start the loopback test. 0=Clear LoopBackTestStatus and LoopBackTestDone.						

D10F0x4C_x4000_0018 Misc Control

Bits	Description
31:12	Reserved.
11:8	InterPacketGapAdjustCounter . Read-write. Reset: 4h. Specifies the counter used to adjust the inter-packet gap for test packet.
7:3	Reserved.
2	TestPacketInterPacketGapEnable . Read-write. Reset: 1. 1=Enable inter-packet gap function for general test packet mode.
1	Reserved.
0	U2IFPowerSavingEnable . Read-write. Reset: 1. 1=Enable power saving clock gating; dynamic clock gating is enabled when U2IF trans_state is in idle state.

D10F0x4C_x4000_0020 USB SCLK Event Counter 0

Bits	Description
31:0	UsbSCLKEventCnt0Lo . Read-only. Reset: 0. USB SCLK Event Counter 0[31:0].

D10F0x4C_x4000_0024 USB SCLK Event Counter 1

Bits	Description
31:0	UsbSCLKEventCnt1Lo . Read-only. Reset: 0. USB SCLK Event Counter 1[31:0].

D10F0x4C_x4000_0028 USB SCLK Event Counter Select

Bits	Description
31:24	UsbSCLKEventCnt1Hi . Read-only. Reset: 0. USB SCLK Event Counter 1[39:32].
23:16	UsbSCLKEventCnt0Hi . Read-only. Reset: 0. USB SCLK Event Counter 0[39:32].
15:8	UsbSCLKEventSel1 . Read-write. Reset: 0. Selects event to be counted by USB SCLK Event Counter 1.
7:0	UsbSCLKEventSel0 . Read-write. Reset: 0. Selects event to be counted by USB SCLK Event Counter 0.

D10F0x4C_x4000_002C USB SCLK Event Counter Control

Bits	Description
31:3	Reserved.
2	UsbSCLKEventCntShadow . Read-write. Reset: 0. 1=Transfer USB SCLK event counter to shadow register.
1	UsbSCLKEventCntResetB . Read-write. Reset: 1. 0=Resets USB SCLK event counters.
0	UsbSCLKEventCntEn . Read-write. Reset: 0. 1=Enable USB SCLK event counters.

D10F0x4C_x4000_0048 LPM Control

Bits	Description			
31:18	Reserved.			
17	CfguP1VirLpmRespEn: Port1 Virtual LPM Response Enable. Read-write. Reset: 0. 0=Disable virtual LPM Response. 1=Force a virtual response of port 1 LPM transaction. The type of response is determined by CfguP1VirLpmResp.			
16:14	CfguP1VirLpmResp: Port1 Virtual LPM Response. Read-write. Reset: 0.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	ACK	100b	Reserved
	001b	Reserved	101b	Reserved
	010b	STALL	110b	TIMEOUT
	011b	NYET	111b	Reserved
13	CfguP0VirLpmRespEn: Port0 Virtual LPM Response Enable. Read-write. Reset: 0. 0=Disable virtual LPM Response. 1=Force a virtual response of port 0 LPM transaction. The type of response is determined by CfguP0VirLpmResp.			
12:10	CfguP0VirLpmResp: Port0 Virtual LPM Response. Read-write. Reset: 0.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	ACK	100b	Reserved
	001b	Reserved	101b	Reserved
	010b	STALL	110b	TIMEOUT
	011b	NYET	111b	Reserved
9	CfguDevRecoveryDis: Device Recovery Timer Disable. Read-write. Reset: 0. 1=xHC does not wait for the device recovery time.			

8:5	CfguRWakeRsmDuration[3:0]: Remote Wake Resume Duration. Read-write. Reset: 0. Software sets this field to indicate how long the xHC should stay in L1Resuming after remote wake is detected. The L1 Resume Timer loads this duration after remote wake is detected and HLE is 0. When the timer expires, the Root Hub state jumps to SENDEOR.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0000b	60 us	1011b-0011b	60 us + value * 75 us
	0001b	135 us	1100b	960 us
	0010b	210 us	1111b-1101b	Reserved
4:0	CfguL1ResidencyDuration: L1 Residency Duration. Read-write. Reset: 0. BIOS: 1. Software sets this field to indicate the minimum duration that the xHC should stay in L1Suspend. The L1 Residency Timer loads this duration when LPM transaction ACK is received and HLE is 0. When the timer expires and there is either Hardware Initiated L1 Resume Request or Remote Wake detected, the Root Hub state jumps to L1Resuming.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00000b	50 us	11110b-00010b	(value + 1)* 50 us
	00001b	100 us	11111b	1.6 ms

D10F0x4C_x4000_0050 USB Common PHY Control 2BIOS: See [2.17.2.8 \[xHC USB2.0 Common PHY Calibration\]](#).

Bits	Description
31:4	Reserved.
3:0	BgAdj. Read-write. Reset: 6. Bandgap voltage adjust.

D10F0x4C_x4000_0054 USB Common PHY Control 3

Bits	Description
31:2	Reserved.
1	CalEnable. Read-write. Reset: 0. 1=Enable calibration.
0	Reserved.

D10F0x50 PME Capability

Bits	Description
31:27	PmeSupport. Read-only. Reset: 19h. Indicates the power states in which the function may assert PME#. For each bit, 0=The function is not capable of asserting the PME# signal while in that power state.
	<u>Bit</u> <u>Definition</u>
	[0] 1=PME# can be asserted from D0
	[1] 1=PME# can be asserted from D1
	[2] 1=PME# can be asserted from D2
	[3] 1=PME# can be asserted from D3hot
	[4] 1=PME# can be asserted from D3cold
26	D2Support. Read-only. Reset: 0. 0=This function doesn't support the D2 Power Management State.
25	D1Support. Read-only. Reset: 0. 0=This function doesn't support the D1 Power Management State.

24:22	AuxCurrent. Read-only. Reset: 0. Specifies the 3.3 V auxiliary current requirements for the PCI function. Since D10F0x54[Data] is implemented by this function, reads of this field must return a value of 000b; D10F0x54[Data] takes precedence over this field for 3.3 V auxiliary current requirement reporting.
21	DSI: Device Specific Initialization. Read-only. Reset: 0. This bit indicates whether special initialization of this function is required (beyond the standard PCI configuration header) before the generic class device driver is able to use it.
20	Reserved.
19	PmeClock: PME clock. Read-only. Reset: 0. 0=Indicates that no PCI clock is required for the function to generate PME#.
18:16	Version. Read-only. Reset: 011b. 011b=Indicates that this function complies with Revision 1.2 of the PCI Power Management Interface Specification.
15:8	NextItemPointer: Next Item Pointer. Read-only. Reset: 70h. Points to the location of next item in the function's capability list.
7:0	CapId. Read-only. Reset: 1. The linked list item is for PCI Power Management.

D10F0x54 PME Control / Status

Bits	Description
31:24	Data. Read-only. Reset: 0. Reports the state dependent data requested by D10F0x54[DataSelect] . The value of this field is scaled by D10F0x54[DataScale] .
23:16	Reserved.
15	PmeStatus. Read; set-by-hardware; write-1-to-clear. Cold reset: 0. BIOS: See 2.17.2.14 . 1=The PME# signal is asserted, which is independent of PmeEn. 0=PME# is de-asserted.
14:13	DataScale. Read-only. Reset: 0. Indicates the scaling factor to be used when interpreting the value of D10F0x54[Data] . The value and meaning of this field varies depending on which data value has been selected by D10F0x54[DataSelect] .
12:9	DataSelect. Read-only. Reset: 0. Selects which data is to be reported through D10F0x54[Data] and D10F0x54[DataScale] .
8	PmeEn. Read-write. Cold reset: 0. 1=Enable the function to assert PME# if PmeStatus=1. 0=PME# assertion is disabled.
7:4	Reserved.
3	NoSoftReset. Read-only. Reset: 1. 1=Upon transitioning from D3hot to D0 because of PowerState, devices do not perform an internal reset ; Configuration context is preserved; No additional operating system intervention is required to preserve configuration context beyond writing the PowerState bits. 0=Upon transitioning from D3hot to D0 via software control of the PowerState bits, devices do perform an internal reset; Configuration context is lost; Full reinitialization sequence is needed to return the device to D0 Initialized. Regardless of this bit, devices that transition from D3hot to D0 by a system or bus segment reset returns to the device state D0 uninitialized with only PME context preserved if PME is supported and enabled.

2	Reserved.												
1:0	<p>PowerState. Read-only. Reset: 0. This field determines the current power state of a function and sets the function into a new power state. If software attempts to write an unsupported, optional state to this field, the write operation must be completed normally on the bus; however, the data is discarded and no state change occurs.</p> <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>D0</td><td>10b</td><td>D2</td></tr><tr><td>01b</td><td>D1</td><td>11b</td><td>D3hot</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	D0	10b	D2	01b	D1	11b	D3hot
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	D0	10b	D2										
01b	D1	11b	D3hot										

D10F0x60 SBRN

Bits	Description																				
31:24	Reserved.																				
23:20	DBESLD: Default Best Effort Service Latency Deep. Read-only. Reset: 0h. Vendor Defined.																				
19:16	DBESL: Default Best Effort Service Latency. Read-only. Reset: 0h. Vendor Defined.																				
15:14	Reserved.																				
13:8	<p>FLAdj: Frame Length Timing Value. Read-only. Reset: 20h. Each decimal value change to this register corresponds to 16 high-speed bit times. The SOF cycle time (number of SOF counter clock periods to generate a SOF microframe length)=59488 + 16*FLAdj.</p> <table> <tr> <th><u>Bits</u></th><th><u>Frame Length (# HS bit times)</u></th></tr> <tr> <td>0</td><td>59488</td></tr> <tr> <td>1</td><td>59504</td></tr> <tr> <td>2</td><td>59520</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>31</td><td>59984</td></tr> <tr> <td>32</td><td>60000</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>62</td><td>60480</td></tr> <tr> <td>63</td><td>60496</td></tr> </table>	<u>Bits</u>	<u>Frame Length (# HS bit times)</u>	0	59488	1	59504	2	59520	31	59984	32	60000	62	60480	63	60496
<u>Bits</u>	<u>Frame Length (# HS bit times)</u>																				
0	59488																				
1	59504																				
2	59520																				
...	...																				
31	59984																				
32	60000																				
...	...																				
62	60480																				
63	60496																				
7:0	SBRN: Serial Bus Specification Release Number. Value: 30h. Specifies the release of the Universal Serial Bus Specification with which this Universal Serial Bus Host Controller module is compliant with.																				

D10F0x70 MSI Control

Bits	Description
31:25	Reserved.
24	PVMC: Per-vector masking capable. Read-only. Reset: 0. 1=The function supports MSI per-vector masking. 0=The function does not support MSI per-vector masking.
23	C64: 64-bit Address Capable. Read-only. Reset: 1. 1=The function is capable of sending a 64-bit message address. 0=The function is not capable of sending a 64-bit message address.

22:20	MME: Multiple Message Enable. Read-write. Reset: 0. System software writes to this field to indicate the number of allocated messages. <table><tr><td><u>Bits</u></td><td><u># of messages allocated</u></td><td><u>Bits</u></td><td><u># of messages allocated</u></td></tr><tr><td>000b</td><td>1</td><td>100b</td><td>16</td></tr><tr><td>001b</td><td>2</td><td>101b</td><td>32</td></tr><tr><td>010b</td><td>4</td><td>111b-110b</td><td>Reserved</td></tr><tr><td>011b</td><td>8</td><td></td><td></td></tr></table>				<u>Bits</u>	<u># of messages allocated</u>	<u>Bits</u>	<u># of messages allocated</u>	000b	1	100b	16	001b	2	101b	32	010b	4	111b-110b	Reserved	011b	8		
<u>Bits</u>	<u># of messages allocated</u>	<u>Bits</u>	<u># of messages allocated</u>																					
000b	1	100b	16																					
001b	2	101b	32																					
010b	4	111b-110b	Reserved																					
011b	8																							
19:17	MMC: Multiple Message Capable. Read-only. Reset: 011b. System software reads this field to determine the number of requested messages. 011b=8 messages requested.																							
16	MSIE: MSI Enable. Read-write. Reset: 0. 1=MSI is enabled and INTx# pins are not used to generate interrupts. 0=MSI is disabled and the traditional pins are used to request service.																							
15:8	NextItemPointer: Next Item Pointer. Read-only. Reset: 90h. Points to next the capability structure.																							
7:0	Capability. Read-only. Reset: 5h. MSI USB ID.																							

D10F0x74 MSI Address

Bits	Description
31:2	MsiAddress: MSI Address. Read-write. Reset: 0. Specifies the lower bits of system-specified message address [31:2]. Always doubleword aligned.
1:0	Reserved.

D10F0x78 MSI Upper Address

Bits	Description
31:0	MsiUpperAddress: MSI Upper Address. Read-write. Reset: 0. Specifies the system-specified message upper address [61:32].

D10F0x7C MSI Data

Bits	Description
15:0	MsiData: MSI Data. Read-write. Reset: 0. System-specified message.

D10F0x80 MSI Mask Bits

Bits	Description
31:0	MaskBits: Mask Bits. Read-write. Reset: 0. For each mask bit that is set, the function is prohibited from sending the associated message.

D10F0x90 MSI-X Control

Bits	Description
31	MsiXEnable: MSI-X Enable. Read-write. Reset: 0.

30	FunctionMask: Function Mask. Read-write. Reset: 0.
29:27	Reserved.
26:16	TableSize: Table Size. Read-only. Reset: 7h.
15:8	NextItemPointer: Next Item Pointer. Read-only. Reset: A0h.
7:0	CapabilityID: Capability ID. Read-only. Reset: 11h.

D10F0x94 MSI-X Table Offset/Table BIR

Bits	Description			
31:3	TableOffset: Table Offset. Read-only. Reset: 200h. Used as an offset from the address contained by one of the function’s Base Address registers to point to the base of the MSI-X Table. The lower 3 TableBIR bits are masked off (set to zero) by software to form a 32-bit QWORD-aligned offset.			
2:0	TableBIR: Table BIR. Read-only. Reset: 0. Indicates which Base Address register, starting at 10h in the configuration space, is used to map the function’s MSI-X table into memory space. For a 64-bit Base Address register, the TableBIR indicates the lower DWORD.			
	<u>Bits</u>	<u>Base Address Register</u>	<u>Bits</u>	<u>Base Address Register</u>
	0h	10h	4h	20h
	1h	14h	5h	24h
	2h	18h	7h-6h	Reserved
	3h	1Ch		

D10F0x98 MSI-X PBA Offset/PBA BIR

Bits	Description
31:3	PBAOffset: PBA Offset. Read-only. Reset: 210h. Used as an offset from the address contained by one of the function's Base Address registers to point to the base of the MSI-X PBA. The lower 3 PBA BIR bits are masked off (set to zero) by software to form a 32-bit QWORD-aligned offset.
2:0	<p>PBABIR: PBA BIR. Read-only. Reset: 0. Indicates which Base Address register, strating at 10h in the configuration space, is used to map the functions MSI-X PBA into memory space. See: D10F0x94[TableBIR].</p>

D10F0xA0 PCIe® Capability List

Bits	Description
31:30	Reserved.
29:25	IntMsgNum: Interrupt Message Number. Read-only. Reset: 0. This field indicates which MSI/MSI-X vector is used for the interrupt message generated in association with any of the status bits of this Capability structure.
24	SlotImplemented: Slot Implemented. Value: 0.
23:20	DevicePortType: Device/Port Type. Value: 9h. 9h=Indicates Root Complex Integrated Endpoint.
19:16	CapabilityVersion: Capability Version. Value: 2h. Indicates PCI-SIG defined PCI Express Capability structure version number. 2h=PCI Express Base Rev 2.0.

15:8	NextItemPointer: Next Item Pointer. Value: 0. 00h=End of linked list capabilities.
7:0	CapabilityID: Capability ID. Read-only. Reset: 10h. PCI Express Capability.

D10F0xA4 Device Capability

Bits	Description										
31:29	Reserved.										
28	FLRCAbility: Function Level Reset Capability. Read-only. Reset: 0. 0=Function Level Reset is not supported.										
27:26	SlotPowerLimitScale: Captured Slot Power Limit Scale (Upstream Ports only). Value: 0. Specifies the scale used for the SlotPowerLimitValue. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>1.0 x</td></tr> <tr> <td>01b</td><td>0.1 x</td></tr> <tr> <td>10b</td><td>0.01 x</td></tr> <tr> <td>11b</td><td>0.001 x</td></tr> </table>	Bits	Definition	00b	1.0 x	01b	0.1 x	10b	0.01 x	11b	0.001 x
Bits	Definition										
00b	1.0 x										
01b	0.1 x										
10b	0.01 x										
11b	0.001 x										
25:18	SlotPowerLimitValue: Captured Slot Power Limit Value (Upstream Ports only). Read-only. Reset: 0. In combination with SlotPowerLimitScale, specifies the upper limit on power supplied by slot. Power limit (in Watts)=SlotPowerLimitValue * SlotPowerLimitScale.										
17:16	Reserved.										
15	RoleBasedErrorReport: Role-Based Error Reporting. Value: 1. 1=Indicates that the function implements the functionality originally defined in the Error Reporting ECN for PCI Express Base Specification, Revision 1.0a, and later incorporated into PCI Express Base Specification, Revision 1.1.										
14:12	Reserved.										
11:9	EndpointL1AcceptableLatency: Endpoint L1 Acceptable Latency. Value: 111b. This field indicates the acceptable latency that an Endpoint can withstand due to the transition from L1 state to the L0 state. It is essentially an indirect measure of the Endpoint's internal buffering. Power management software uses the reported L1 Acceptable Latency number to compare against the L1 Exit Latencies reported (see below) by all components comprising the data path from this Endpoint to the Root Complex Root Port to determine whether ASPM L1 entry can be used with no loss of performance. 111b=No limit.										
8:6	EndpointL0sAcceptableLatency: Endpoint L0s Acceptable Latency. Value: 111b. This field indicates the acceptable total latency that an Endpoint can withstand due to the transition from L0s state to the L0 state. It is essentially an indirect measure of the Endpoints internal buffering. Power management software uses the reported L0s Acceptable Latency number to compare against the L0s exit latencies reported by all components comprising the data path from this Endpoint to the Root Complex Root Port to determine whether ASPM L0s entry can be used with no loss of performance. 111b=No limit.										
5	ExtTagFieldSup: Extended Tag Field Supported. Value: 0. This bit indicates the maximum supported size of the Tag field as a Requester. 0=Tag field size of 5-bits supported.										

4:3	PhantomFuncSup: Phantom Functions Supported. Value: 0. 0=No Function Number bits are used for Phantom Functions.			
2:0	MaxPayloadSizeSup: Max Payload Size Supported. Value: 0. This field indicates the maximum payload size that the function can support for TLPs.			
	<u>Bits</u>	<u>Payload Size</u>	<u>Bits</u>	<u>Payload Size</u>
	0h	128 bytes max payload size	4h	2048 bytes max payload size
	1h	256 bytes max payload size	5h	4096 bytes max payload size
	2h	512 bytes max payload size	7h-6h	Reserved
	3h	1024 bytes max payload size		

D10F0xA8 Device Control/Status

Bits	Description
31:22	Reserved.
21	TransPending: Transactions Pending. Read-only. Reset: 0. 1=The function has issued Non-Posted Requests which have not been completed. 0=All outstanding Non-Posted Requests have completed or have been terminated by the Completion Timeout mechanism. This bit must also be cleared upon the completion of an FLR.
20	AUXPowerDetected: AUX Power Detected. Read-only. Reset: 0. 1=AUX power is detected by the function.
19	UnsupReqDetected: Unsupported Request Detected. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=The function received an Unsupported Request. Errors are logged in this register regardless of UnsupReqRptEn.
18	FatalErrDetected: Fatal Error Detected. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Fatal errors are detected. Errors are logged in this register regardless of FatalErRptEn.
17	NonFatalErrDetected: Non-Fatal Error Detected. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Nonfatal errors are detected. Errors are logged in this register regardless of NonFatalErrRptEn.
16	CorrErrDetected: Correctable Error Detected. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Correctable errors are detected. Errors are logged in this register regardless of CorrErrRptEn.
15	InitiateFLR: Initiate Function Level Reset. RAZ; write-1-only. Reset: 0. FLR is not supported.
14:12	MaxReadRequestSize. Read-write. Reset: 010b. This field sets the maximum Read Request size for the function as a Requester. The function must not generate Read Requests with size exceeding the set value. 010b=512 bytes maximum Read Request size.
11	EnNoSnoop: Enable No Snoop. Read-write. Reset: 1. 1=Function is permitted to set the No Snoop bit in the Requester Attributes of transactions that it initiates and do not require hardware enforced cache coherency.
10	AuxPowerPMEn: Auxiliary Power PM Enable. Read-write. Cold reset: 0. 1=Enable a function to draw auxiliary (AUX) power independent of PME AUX power. Functions that require AUX power on legacy operating systems should continue to indicate PME AUX power requirements. AUX power is allocated as requested in D10F0x50[AuxCurrent] independent of D10F0x54[PmeEn] . Functions that consume AUX power must preserve the value of this sticky register when AUX power is available and preserve the value through Conventional Reset.
9	PhantomFunctionsEn: Phantom Functions Enable. Value: 0. 0=The Function is not allowed to use Phantom Functions.
8	ExtTagFieldEn: Extended Tag Field Enable. Value: 0. 0=Function is restricted to a 5-bit Tag field.

7:5	MaxPayloadSize. Read-write. Reset: 0. This field sets maximum TLP payload size for the function. as a receiver, the function must handle TLPs as large as the set value. As a Transmitter, the Function must not generate TLPs exceeding the set value. Permissible values that can be programmed are indicated by D10F0xA4[MaxPayloadSizeSup] .			
	<u>Bits</u>	<u>Payload Size</u>	<u>Bits</u>	<u>Payload Size</u>
	0h	128 bytes max payload size	4h	2048 bytes max payload size
	1h	256 bytes max payload size	5h	4096 bytes max payload size
	2h	512 bytes max payload size	7h-6h	Reserved
	3h	1024 bytes max payload size		
4	EnRelaxOrder: Enable Relaxed Ordering. Read-write. Reset: 1. 1= Function is permitted to set the Relaxed Ordering bit in the Attributes field of transactions that it initiates and do not require strong write ordering.			
3	UnsupReqRptEn: Unsupported Request Reporting Enable. Read-write. Reset: 0. This bit, in conjunction with other bits, controls the signaling of Unsupported Requests by sending Error Messages.			
2	FatalErrRptEn: Fatal Error Reporting Enable. Read-write. Reset: 0. This bit, in conjunction with other bits, controls sending ERR_FATAL Messages			
1	NonFatalErrRptEn: Non-Fatal Error Reporting Enable. Read-write. Reset: 0. This bit, in conjunction with other bits, controls sending ERR_NONFATAL Messages			
0	CorrErrRptEn: Correctable Error Reporting Enable. Read-write. Reset: 0. This bit, in conjunction with other bits, controls sending ERR_COR Messages			

D10F0xC4 Device Capabilities 2

Bits	Description
31:12	Reserved.
11	LTRMechanismSupported: LTR Mechanism Supported. Read-only. Reset: 1. 1=Latency Tolerance Reporting (LTR) mechanism capability is supported.
10:5	Reserved.
4	CompletionTimeoutDisableSupported: Completion Timeout Disable Supported. Read-only. Reset: 1. 1=The Completion Timeout Disable mechanism is supported.
3:0	CompletionTimeoutRangesSupported: Completion Timeout Ranges Supported. Read-only. Reset: 0. 0=Completion Timeout programmability mechanism is not supported.

D10F0xC8 Device Control/Status 2

Bits	Description
31:11	Reserved.
10	LTRMechanismEnable: LTR Mechanism Enable. Read-write. Reset: 0. 1=Enable the Latency Tolerance Reporting (LTR) mechanism.
9:5	Reserved.
4	CompletionTimeoutDisable: Completion Timeout Disable. Read-write. Reset: 0. 1=Disable the Completion Timeout mechanism.
3:0	CompletionTimeoutValue: Completion Timeout Value. Read-only. Reset: 0.

D10F0x100 LTR Extended Capability Header

Bits	Description
31:20	NextCapabilityOffset: Next Capability Offset. Read-only. Reset: 00h. 00h=End of capability list.
19:16	CapabilityVersion: Capability Version. Read-only. Reset: 1.
15:0	PCIExpressExtendedCapabilityID: PCI Express® Extended Capability ID. Read-only. Reset: 18h. Extended Capability ID for Latency Tolerance.

D10F0x104 Max Latency

Bits	Description
31:29	Reserved.
28:26	MaxNoSnoopLatencyScale: Max No-Snoop Latency Scale. Read-only. Reset: 0. This register provides a scale for the value contained within MaxNoSnoopLatencyValue. Encoding is the same as the Latency Scale fields in the LTR Message.
25:16	MaxNoSnoopLatencyValue: Max No-Snoop Latency Value. Read-only. Reset: 0. Along with MaxNoSnoopLatencyScale, this register specifies the maximum no-snoop latency that a device is permitted to request. Software should set this to the platform's maximum supported latency or less.
15:13	Reserved.
12:10	MaxSnoopLatencyScale: Max Snoop Latency Scale. Read-only. Reset: 0. This register provides a scale for the value contained within MaxSnoop LatencyValue. Encoding is the same as the Latency Scale fields in the LTR Message.
9:0	MaxSnoopLatencyValue: Max Snoop Latency Value. Read-only. Reset: 0. Along with MaxSnoopLatencyScale, this register specifies the maximum no-snoop latency that a device is permitted to request. Software should set this to the platform's maximum supported latency or less.

3.26.4.2.1.3 USB xHCI Capability Registers

The base address of the xHCI Capability register space is specified by {[D10F0x14](#)[Bar1], [D10F0x10](#)[Bar0], 0h}.

XHCI_CAPx02 HC Interface Version

Bits	Description
15:0	HCIVersion: Host Controller Interface Version Number. Read-only. Reset: 96h. Contains a BCD encoding of the xHCI specification revision number supported by this host controller. The most significant byte of this register represents a major revision and the least significant byte is the minor revision. e.g. 0100h corresponds to xHCI version 1.0. Writing to XHCL_PMx30 [HCIVersion10En] updates this field.

3.26.4.2.2 xHCI Power Management Registers

xHCI power management registers are accessed through the AcpiMmio region. They range from FED8_0000h+1C00h to FED8_0000h+1CFFh. See [PMx04\[Mmio\]](#). These registers reside in USB 3.0 and can hold their values during S3 or S5 state if the xHC host is programmed into D3 state before entering into S3/S5 state.

XHCI_PMx00 xHCI Config 0

Bits	Description
31	Reserved.
30	FwPreloadComplete: Firmware Preload Complete. Read-only; updated-by-hardware. Reset: 0. 1=Firmware preload is complete. 0=FwPreloadStart is cleared by software.
29	FwPreloadStart: Firmware Preload Start. Read-write. Reset: 0. BIOS: See 2.17.2.13 . When set from 0 to 1, firmware preload is initiated. Upon completion of firmware preload (FwPreloadComplete==1), this field should be programmed to 0.
28	FwLoadMode: Firmware Load Mode. Read-write. Reset: 1. Controls whether the firmware executes a bootstrap routine to load firmware into instruction ram, or whether instruction ram is to be pre-loaded. 0=xHCI executes bootstrap routine. 1=xHCI does not execute bootstrap routine.
27	Reserved.
26	Xhc0BlmCgDis: xHC0 BLM Clock Gating Disable. Read-write. Reset: 0. IF (U3CoreReset==0) THEN clock gating takes effect. ENDIF. 1=Disable xHC0 BLM Clock Gating.
25	AlGcgDis: A-Link Global Clock Gating Disable. Read-write. Reset: 0. 1=Disable USB3.0 A-Link Global Clock Gating.
24	BlGcgDis: B-Link Global Clock Gating Disable. Read-write. Reset: 0. 1=Disable USB3.0 B-Link Global Clock Gating.
23:22	Reserved.
21	XhcSmibEn: xHC SMIB Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable XHC_SMIB to ACPI controller.
20:17	Reserved.
16	Reserved.
15	Reserved.
14	Reserved.
13	Reserved.
12	Reserved.
11	Xhc0Reset: xHC0 Reset. Read-write. Reset: 0. 1=Reset xHC0 core logic.
10	U3CoreReset: USB3 Core Reset. Read-write. Reset: 1. BIOS: See 2.17.2.13 . 1=Reset the USB3.0/xHCI (xHC0) core logic. 0=xHC clock gating enable.
9	U3pPhyReset: USB3 PHY Reset. Read-write. Reset: 1. 1=Reset SSPHYIF power control logic in 125 MHz clock domain.
8	U3pPllReset: USB3 PHY PLL Reset. Read-write. Reset: 1. 1=Reset USB3.0 PHY PLL and SSPHYIF power control logic in LFPS clock domain.
7	U3pLock: USB3 PHY PLL Lock. Read-only. Reset: 0. 1=USB3.0 PHY PLL is locked.
6:2	Reserved.

1	Reserved.
0	Xhci0Enable. Read-write. Reset: 0. BIOS: See 2.17.2.4. 1=Enable xHCI0.

XHCI_PMx04 xHCI Firmware Addr 0

Bits	Description
31	XhciFwPreloadType. Read-write. Reset: 0. BIOS: See 2.17.2.13. Controls the destination of the pre-load operation. 0=Instruction RAM. 1=Boot RAM.
30:17	Reserved.
16:0	XhciFwRomAddr. Read-write. Reset: 0. BIOS: See 2.17.2.13. Specifies the address of the first byte of application firmware in external ROM.

XHCI_PMx08 xHCI Firmware Addr 1

Bits	Description
31:16	XhciFwSize: xHCI Firmware Size. Read-write. Reset: 0. BIOS: See 2.17.2.13. Specifies the size of the application firmware in the external ROM.
15:0	XhciFwRamAddr: xHCI Firmware Start Address. Read-write. Reset: 0. BIOS: See 2.17.2.13. Specifies the address where the first byte of application firmware is to be stored in boot RAM or instruction RAM.

XHCI_PMx10 xHCI Memory Config

Bits	Description																
31:23	Reserved.																
22:16	Reserved.																
15:8	<p>CcuMode: Clock Control Mode. Read-write. Reset: 07h. BIOS: 3Dh. This field contains a set of bits which, when set, enable individual features of the clock control unit.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>1=Enable power control mode.</td></tr> <tr> <td>[1]</td><td>1=Enable SuperSpeed remote wake mode.</td></tr> <tr> <td>[2]</td><td>1=Enable PCLK control mode.</td></tr> <tr> <td>[3]</td><td>1=Enable Memory Sleep Sequencing.</td></tr> <tr> <td>[4]</td><td>1=Enable Stop CPU mode.</td></tr> <tr> <td>[5]</td><td>1=Enable firmware clock control to start firmware after PCI reset is released</td></tr> <tr> <td>[7:6]</td><td>Reserved.</td></tr> </table>	Bit	Definition	[0]	1=Enable power control mode.	[1]	1=Enable SuperSpeed remote wake mode.	[2]	1=Enable PCLK control mode.	[3]	1=Enable Memory Sleep Sequencing.	[4]	1=Enable Stop CPU mode.	[5]	1=Enable firmware clock control to start firmware after PCI reset is released	[7:6]	Reserved.
Bit	Definition																
[0]	1=Enable power control mode.																
[1]	1=Enable SuperSpeed remote wake mode.																
[2]	1=Enable PCLK control mode.																
[3]	1=Enable Memory Sleep Sequencing.																
[4]	1=Enable Stop CPU mode.																
[5]	1=Enable firmware clock control to start firmware after PCI reset is released																
[7:6]	Reserved.																
7:3	Reserved.																
2	Reserved.																

1	XhcNCpuMemSlpDis: Non-CPU Memory Sleep Disable. Read-write. Reset: 0. Controls whether the sleep feature is disabled on xHCI Non-Cpu internal SRAMs. 0=Do not disable sleep. 1=Disable sleep.
0	XhcCpuMemSlpDis: CPU Memory Sleep Disable. Read-write. Reset: 0. Controls whether the sleep feature is disabled on xHCI Embedded CPU internal SRAMs. 0=Do not disable sleep. 1=Disable sleep.

XHCI_PMx14 PLL Control

Bits	Description
31:0	Reserved.

XHCI_PMx20 USB2.0 Wake Control

Bits	Description
31:26	Reserved.
25:24	SysBW: System Bandwidth. Read-write. Reset: 0. BIOS: 1. This field is used to provide information to the controller about the available system bandwidth.
23:22	U2SE1DisconMode: xHC USB2 Interface SE1 Disconnect Mode. Read-write. Reset: 1. 0=Take SE1 > 2.5us as a disconnect. 1=Do not take SE1 as a disconnect.
21	Reserved.
20:18	Reserved.
17:16	Reserved.
15	Reserved.
14:13	Reserved.
12:0	Reserved.

XHCI_PMx30 xHCI 1.0 Enable

Bits	Description
31:16	Reserved.
15	HCIVersion10En. Read-write. Reset: 0. BIOS: 1. Controls the host controller interface version number reported in XHCI_CAPx02 . 0=HCI Version is 0096h. 1=HCI Version is 0100h.
14	MSEFrameIdEn: Missed Server Error Frame ID Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable a clarification in xHCI 1.0 specifying the conditions under which a Missed Service Error should be detected based on Frame ID. 0=Disable.
13:12	Reserved.
11	SoftRetryEn: Soft Retry Enable. Read-write. Reset: 0. BIOS: 1. 0=Do not support soft retry. 1=Support soft retry.
10	SkipMsIocEvtEn: Skip Missed Service IOC Event Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable the parsing of TRBs during re-sync of an ISO pipe following detection of a Missed Service Error. 0=Disable. Always enable this bit when SkipTrbIocEvtEn==1.

9	EpStateUpdateChangeEn: EPState Update Change Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable a clarification in xHCI 1.0 specifying that when an endpoint transitions from Stopped to Running due to a doorbell ring, the EP State shall be updated to Running before any Transfer Events are generated. 0=Disable.
8	CASEn: Cold Attach Status Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable the xHCI 1.0 feature Cold Attach Status flag. 0=Disable.
7	SbdCapObsolete: SBD Reporting Capability Obsolete. Read-write. Reset: 0. BIOS: 1. 1=Enable xHCI 1.0 feature which makes Secondary Bandwidth Domain Reporting mandatory. 0=Disable.
6	SkipTrbLocEvtEn: Skip TRB IOC Event Enable. Read-write. Reset: 0. BIOS: 1. 1=Enable xHCI 1.0 features related to the parsing of TRBs and generation of events while skipping over TRBs due to errors and short packets. 0=Disable.
5	Reserved.
4	Reserved.
3	SwLpmEn: Software LPM Enable. Read-write. Reset: 0. BIOS: 1. 0=Disable software controlled LPM feature. 1=Enable software controlled LPM feature.
2	FseEn: FSE Enable. Read-write. Reset: 0. BIOS: 1. 0=Disable FSE feature. 1=Enable FSE feature.
1	IntBlockEn: Interrupt Blocking Enable. Read-write. Reset: 0. BIOS: 1. 0=Disable interrupt blocking. 1=Enable interrupt blocking.
0	Xhci10En: xHCI 10 Enable. Read-write. Reset: 0. Global enable bit for xHCI 1.0 features. All xHCI 1.0 features may be enabled by setting this bit, or can be individually enabled by setting the individual feature enables. 1=Enable all xHCI 1.0 features.

XHCI_PMx48 SSPHY ACPI Indirect Index

Bits	Description
31:16	Reserved.
15:2	IndirectIndex: Indirect Index. Read-write. Reset: 00h.
1:0	Reserved.

XHCI_PMx4C SSPHY ACPI IndirectData

Bits	Description
31:0	IndirectData: Indirect Data. Read-write. Reset: 0000_0000h.

XHCI_PMx8C SSPHY Common Control 0

Bits	Description
31:25	Reserved.
24	CrPllCalibEn. Read-write. Reset: 0h. BIOS: See 2.17.2.10 . 1=Auto calibration is enabled; use calibrated value as the VCO setting. 0=Auto calibration is disabled; Use CP_PLL_VCO_TUNE[3:0] as the VCO setting if auto calibration has not been enabled; Use previously calibrated value as the VCO setting if auto calibration has been enabled once.
23:20	Reserved.

19:16	PlIVcoTune[3:0] . Read-write. Reset: 0h. BIOS: See 2.17.2.10 . Specifies PLL VCO range initial setting (in Thermometer code). Valid settings are 0000b, 0001b, 0011b, 0111b, and 1111b. Programming invalid values may result in unpredictable behavior.
15:0	Reserved.

XHCI_PMxA0 SPI BAR0

Bits	Description
31:16	XhcSpiDataType0Size . Read-write. Reset: 0. Type 0 data size.
15:0	XhcSpiDataType0Addr . Read-write. Reset: 0. Type0 data ROM address.

XHCI_PMxA4 SPI BAR1

Bits	Description
31:16	XhcSpiDataType1Size . Read-write. Reset: 0. Type 1 data size.
15:0	XhcSpiDataType1Addr . Read-write. Reset: 0. Type 1 data ROM address.

XHCI_PMxA8 SPI BAR2

Bits	Description
31:16	XhcSpiDataType2Size . Read-write. Reset: 0. Type 2 data size.
15:0	XhcSpiDataType2Addr . Read-write. Reset: 0. Type 2 data ROM address.

XHCI_PMxAC SPI BAR3

Bits	Description
31:16	XhcSpiDataType3Size . Read-write. Reset: 0. Type 3 data size.
15:0	XhcSpiDataType3Addr . Read-write. Reset: 0. Type 3 data ROM address.

XHCI_PMxB0 SPI Valid Base

Bits	Description
31:26	SpiBase3 . Read-write. Reset: 0. Specifies the offset in SPI data block of type 3 data.
25	Reserved.
24	SpiBar3Vld: SPI BAR3 Valid . Read-write. Reset: 0. 1=SPI_BAR4 register is valid.
23:18	SpiBase2 . Read-write. Reset: 0. Specifies the offset in SPI data block of type 2 data.
17	Reserved.
16	SpiBar2Vld: SPI BAR2 Valid . Read-write. Reset: 0. 1=SPI_BAR2 register is valid.
15:10	SpiBase1 . Read-write. Reset: 0. Specifies the offset in SPI data block of type 1 data.
9	Reserved.

8	SpiBar1Vld: SPI BAR1 Valid. Read-write. Reset: 0. 1=SPI_BAR1 register is valid.
7:2	SpiBase0. Read-write. Reset: 0. Specifies the offset in SPI data block of type 0 data.
1	Reserved.
0	SpiBar0Vld: SPI BAR0 Valid. Read-write. Reset: 0. 1=SPI_BAR0 register is valid.

XHCI_PMxB4 SPI Misc

Bits	Description
31:16	Reserved.
15:0	XhcSpiFwId: SPI Firmware ID. Read-write. Reset: 0. Firmware Version ID.

XHCI_PMxB8 FW_DMA_ADDR_LOW

Bits	Description
31:0	FW_DMA_ADDR_LOW. Read-write. Reset: 0. When xHC FW is in main memory, system software sets the lower 32 bits of begin address for xHC FW inside main memory.

XHCI_PMxBC FW_DMA_ADDR_HIGH

Bits	Description
31:0	FW_DMA_ADDR_HIGH. Read-write. Reset: 0. When xHC FW is in main memory, system software sets the upper 32 bits of begin address for xHC FW inside main memory.

XHCI_PMx[FC:C0] SPI Data Block N

Bits	Description
31:0	XhcSpiDataBlock. Read-write. Reset: 0. SPI Data Block.

3.26.4.3 USB Legacy Registers

This register space is used to provide USB legacy support. Each of the registers is located on a 32-bit boundary. The offsets of the registers are relative to the AcpiMMio base (FED8_0000h). Three of the operational registers ([HCEx4C](#), [HCEx44](#) and [HCEx48](#)) are accessible at [IO060](#) and [IO064](#) when emulation is enabled. Reads and writes to the registers using IO addresses have side effects as outlined in the table below.

Table 259: USB Legacy Registers and IO Ports

IOAddress	Cycle Type	Registers Contents Accessed/Modified	Side Effects
IO060	IN	HCEx48 [HCE Output]	IN from port 60h sets HCEx4C [OutputFull] to 0
IO060	OUT	HCEx44 [HCE Input]	OUT to port 60h sets HCEx4C [InputFull] to 1 and HCEx4C [CmdData] to 0.

Table 259: USB Legacy Registers and IO Ports

IOAddress	Cycle Type	Registers Contents Accessed/Modified	Side Effects
IO064	IN	HCEx4C [HCE Status]	IN from port 64h returns current value of HCEx4C [HCE Status] with no other side effect.
IO064	OUT	HCEx44 [HCE Input]	OUT to port 64h sets HCEx4C[InputFull] to 0 and HCEx4C[CmdData] to 1.

HCEx40 HCE Control

Reset: 0000_0000h.

Bits	Description
31:9	Reserved.
8	A20State . Read-write. Indicates current state of Gate A20 on keyboard controller. Used to compare against value written to IO port 60h when GateA20Sequence is active.
7	IRQ12Active . Read; write-1-to-clear. 1=A positive transition on IRQ12 from the keyboard controller has occurred.
6	IRQ1Active . Read; write-1-to-clear. 1=A positive transition on IRQ1 from the keyboard controller has occurred.
5	GateA20Sequence . Read-write. Set by HC when a data value of D1h is written to IO port 64h. Cleared by HC on write to IO port 64h of any value other than D1h.
4	ExternallIRQEn . Read-write. 1=Enable IRQ1 and IRQ12 from the keyboard controller to cause an emulation interrupt. The function controlled by this bit is independent of the setting of the Emulation-Enable bit in this register.
3	IRQEn . Read-write. 1=Enable the HC generation of IRQ1 or IRQ12 as long as the (HCEx4C[OutputFull] ==1). IF (HCEx4C[AuxOutputFull] ==0) THEN IRQ1 is generated. ELSE IRQ12 is generated.
2	CharacterPending . Read-write. 1=An emulation interrupt is generated when HCEx4C[OutputFull] =0.
1	EmulationInterrupt . Read-only. This bit is a static decode of the emulation interrupt condition.
0	EmulationEnable . Read-write. 1=Enable HC legacy keyboard and mouse emulation. The HC decodes accesses to IO060 and IO064 and generates IRQ1 and/or IRQ12 when appropriate. Additionally, the HC generate s an emulation interrupt at appropriate times to invoke the emulation software.

HCEx44HCE Input

IO data that is written to ports 60h and 64h is captured in this register when emulation is enabled. This register may be read or written directly by accessing it with its memory address in the Host Controller's operational register space. When accessed directly with a memory cycle, reads and writes of this register have no side effects.

Bits	Description
31:8	Reserved.
7:0	InputData . Read-write. Reset: 0. This register holds data that is written to IO ports 60h and 64h.

HCEx48 HCE Output

The data placed in this register by the emulation software is returned when IO port 60h is read and emulation is enabled. On a read of this location, [HCEx4C\[OutputFull\]](#) is set to 0.

Bits	Description
31:8	Reserved.
7:0	OutputData. Read-write. Reset: 0. This register hosts data that is returned when an IO read of port 60h is performed by application software.

HCEx4C HCE Status

Reset: 0000_0000h. The contents of the HceStatus Register are returned on an IO Read of port 64h when emulation is enabled. Reads and writes of port 60h and writes to port 64h can cause changes in this register. Emulation software can directly access this register through its memory address in the Host Controller's operational register space. Accessing this register through its memory address produces no side effects.

Bits	Description
31:8	Reserved.
7	Parity. Read-write; updated-by-hardware. 1=Indicates parity error on keyboard/mouse data.
6	TimeOut. Read-write; updated-by-hardware. 1=Indicates a timeout.
5	AuxOutputFull. Read-write; updated-by-hardware. IRQ12 is asserted whenever this bit is set to 1 and OutputFull is set to 1 and the IRQEn bit is set.
4	InhibitSwitch. Read-write; updated-by-hardware. This bit reflects the state of the keyboard inhibit switch and is set if the keyboard is NOT inhibited.
3	CmdData. Read-write; updated-by-hardware. The HC sets this bit to 0 on an IO write to port 60h and to 1 on an IO write to port 64h.
2	Flag. Read-write; updated-by-hardware. Nominally used as a system flag by software to indicate a warm or cold boot.
1	InputFull. Read-write; updated-by-hardware. Except for the case of a Gate A20 sequence, this bit is set to 1 on an IO write to address 60h or 64h. While this bit is set to 1 and emulation is enabled, an emulation interrupt condition exists.
0	OutputFull. Read-write; updated-by-hardware. The HC sets this bit to 0 on a read of IO port 60h. If HCEx40[IRQEn] ==1 and AuxOutputFull==0, then an IRQ1 is generated as long as this bit is set to 1. If HCEx40[IRQEn] ==1 and AuxOutputFull==1, then an IRQ12 is generated as long as this bit is set to 1. While this bit is 0 and HCEx40[CharacterPending] ==1, an emulation interrupt condition exists.

HCEx50HCE IntrEn

Bits	Description
31:11	Reserved.
10	A20State_inv. Read-write. Reset: 0. 1=Set to 1 to use inverted version of A20State.
9:8	SOFSrc. Read-write. Reset: 00b. Indicates which HCI_MSofN source is used in USB Legacy. 0=HCI_MSofN from EHCI1 (Dev12, func0); 1=HCI_MSofN from EHCI2 (Dev12, func0); 2=HCI_MSofN from EHCI3 (Dev12, func0).

7:5	SOFCounter . Read-write. Reset: 101b. Specifies the amount of SOF number that emulation interrupt has to wait before SMI is sent.
4	EmulationSmiEn . Read-write. Reset: 0. 1=Gnerate SMI if emulation interrupt happens.
3	BlockIRQ12 . Read-write. Reset: 0. 1=Block IRQ12.
2	BlockIRQ1 . Read-write. Reset: 0. 1=Block IRQ1.
1	EnIRQ12 . Read-write. Reset: 1. 1=Enable IRQ12 active.
0	EnIRQ1 . Read-write. Reset: 1. 1=Enable IRQ1 active.

3.26.5 HD Audio Controller

3.26.5.1 Device 14h Function 2 (Audio Controller) Configuration Registers

D14F2x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: device ID. Read-only. Reset: 780Dh.
15:0	VendorID: vendor ID. Read-only. Reset: 1022h.

D14F2x04 Status/Command

Reset: 0010_0000h.

Bits	Description
31:30	Reserved.
29	ReceivedMasterAbort: received master abort. Read; write-1-to-clear. 1=A completion with an unsupported request completion status was received.
28:21	Reserved.
20	CapList: capability list. Read-only. 1=capability list supported.
19	IntStatus: interrupt status. Read-only; updated-by-hardware. 1=INTx interrupt message pending. This bit is not set by MSI
18:11	Reserved.
10	IntDis: interrupt disable. Read-write. 1=INTx interrupt messages generation disabled. This bit does not affect the generation of MSI.
9:3	Reserved.
2	BusMasterEn: bus master enable. Read-write. 1=Memory read and write request generation enabled.
1	MemAccessEn: IO access enable. Read-write. This bit controls if memory accesses targeting this device are accepted. 1=Enabled. 0=Disabled.
0	Reserved.

D14F2x08 Class Code/Revision ID

Bits	Description
31:24	BaseClassCode. Read-only. Reset: 04h.
23:16	SubClassCode. Read-only. Reset: 03h.
15:8	ProgramInterface. Read-only. Reset: 00h.
7:0	RevID: revision ID. Read-only. Reset: 03h.

D14F2x0C Header Type

Bits	Description
31:24	BIST . Value: 0.
23:16	HeaderTypeReg . Value: 0.
15:8	LatencyTimer . Value: 0.
7:0	CacheLineSize . Read-write. Reset: 0. This field specifies the system cache line size in units of double words. This field is implemented as a read-write field for legacy compatibility purposes only and has no functional impact.

D14F2x10 Lower Base Address Register

Reset: 0000_0004h.

Bits	Description
31:14	HDABaseAddr[31:14]: low base address . Read-write. Lower Base Address for the HD Audio controller's memory mapped configuration registers.
13:4	Reserved.
3	Pref: prefetchable . Read-only. 0=Non-prefetchable memory region.
2:1	Type: base address register type . Read-only. 10b=64 bit base address register.
0	MemSpace: memory space type . Read-only. 0=Memory mapped base address.

D14F2x14 Upper Base Address Register

Reset: 0000_0000h.

Bits	Description
31:0	HDABaseAddr[63:32]: Upper Base Address . Read-write. Upper Base Address for the HD Audio controller's memory mapped configuration registers.

D14F2x2C Subsystem and Subvendor ID

Reset: 0000_0000h.

Bits	Description
31:16	SubsystemID . Write-once.
15:0	SubsystemVendorID . Write-once.

D14F2x34 Capabilities Pointer

Reset: 0000_0050h.

Bits	Description
31:8	Reserved.
7:0	CapPtr: capabilities pointer . Read-only. Pointer to PM capability.

D14F2x3C Interrupt Line

Reset: 0000_0100h.

Bits	Description
31:24	MaximumLatency. Read-only.
23:16	MinimumGrant. Read-only.
15:12	Reserved.
11:8	InterruptPin: interrupt pin. Read-only. This register reflects the value programs into Interrupt Control Pin register D14F2x44 [InterruptPinControl].
7:0	InterruptLine: interrupt line. Read-write. This field contains the interrupt line routing information. This is not used by the HD Audio controller.

D14F2x40 Misc Control

Read-write. Reset: 0000_0000h.

Bits	Description										
31:23	Reserved.										
22	EnableStopALinkClock. 1=Enable stop A-Link clock indication. 0=Disable.										
21	EnableClockGating. 1=Enable clock gating. 0=Disable.										
20	DisableMinimumRetry. 1=Disable minimum retry on ALink Bus. 0=Enable. When enabled, after the first request of a transaction, it does not generate another request for the same transaction unless notified by AB the data is available.										
19	Reserved.										
18	EnableNoSnoopRequest. 1=Enable No Snoop request to ACPI. 0=Disable. No snoop request to ACPI When enabled and the DMA cycle is No Snoop, ACPI does not generate a wake to CPU in C2 state.										
17	DisableNoSnoopOverride. 1=DisableNoSnoop controlling the No Snoop attribute. 0=Override DisableNoSnoop setting and always generate No Snoop attribute on Buffer Descriptor and Data Buffer DMA.										
16	DisableNoSnoop. 1=No Snoop attribute is disabled on Buffer Descriptor and Data Buffer DMA. 0=Set the No Snoop attribute on Buffer Descriptor and Data Buffer DMA when the Traffic Priority bit is set in the Stream Descriptor.										
15:9	Reserved.										
8	StaticOutputFIFOSizeEnable. 1=Enable Static Output FIFO Size. 0=Output FIFO Size is set dynamically set based on Stream Format.										
7:2	Reserved.										
1:0	StaticOutputFIFOSizeSelect. Static Output FIFO Size is functional only when (D14F2x40 [StaticOutputFIFOSizeEnable]==1). <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>1/8 of the maximum Output FIFO Size.</td></tr> <tr> <td>01b</td><td>1/4 of the maximum Output FIFO size</td></tr> <tr> <td>10b</td><td>1/2 of the maximum Output FIFO Size</td></tr> <tr> <td>11b</td><td>Use the maximum Output FIFO Size</td></tr> </table>	Bits	Definition	00b	1/8 of the maximum Output FIFO Size.	01b	1/4 of the maximum Output FIFO size	10b	1/2 of the maximum Output FIFO Size	11b	Use the maximum Output FIFO Size
Bits	Definition										
00b	1/8 of the maximum Output FIFO Size.										
01b	1/4 of the maximum Output FIFO size										
10b	1/2 of the maximum Output FIFO Size										
11b	Use the maximum Output FIFO Size										

D14F2x44 Interrupt Pin/Capability

Reset: 0000_0001h.

Bits	Description
31:16	Reserved.
15:11	Reserved.
10	BCLKOnInD3 . Read-write. 1=Do not turn off AZ_BCLK in D3.
9	EnAFCap . Read-write. BIOS: 0. 1=Enable Advanced Features Capability. See Table 91 .
8	EnMsiCap . Read-write. BIOS: 1. 1=Enable MSI Capability. See Table 91 .
7:4	Reserved.
3:0	InterruptPinControl . Read-write. Controls the value reports in D14F2x3C [InterruptPin].

D14F2x50 Power Management Capability

Bits	Description
31:27	PmeSupport . Value: 11001b. Indicates PME# can be generated from D0 and D3 states.
26	D2Support: D2 support . Value: 0. Indicates that D2 is not supported in hardware.
25	D1Support: D1 support . Value: 0. Indicates that D1 is not supported in hardware.
24:22	AuxCurrent: auxiliary current . Value: 001b. Indicates 55mA maximum suspend well current is required in the D3cold state.
21	DevSpecificInit: device specific initialization . Value: 0. Indicates that there is no device specific initialization necessary.
20	Reserved.
19	PmeClock . Value: 0. Indicates that no PCI clock is required for the function to generate PME#.
18:16	Version: version . Value: 010b. Indicates this function complies with Revision 1.1 of the PCI Power Management Interface Specification
15:8	NextPtr: next pointer . IF (D14F2x44 [EnAFCap] && D14F2x44 [EnMsiCap]) THEN Value: 60h. ELSEIF (D14F2x44 [EnAFCap]) THEN Value: 70h. ELSEIF (D14F2x44 [EnMsiCap]) THEN Value: 60h. ELSE Value: 00h. ENDIF. Specifies the address of the next capability structure, or zero if this the end of the linked list of capability structures. See Table 91 .
7:0	CapID: capability ID . Value: 01h. Indicates that the capability structure is a PCI power management data structure.

D14F2x54 Power Management Control and Status

Bits	Description
31:16	Reserved.

15	PmeStatus: PME status. Read; set-by-hardware; write-1-to-clear. Cold reset: 0. This bit set when the HD Audio controller asserts the PME# signal, and is independent of the PME Enable bit.			
14:9	Reserved.			
8	PmeEn: PME# enable. Read-write. Cold reset: 0. Enables the function to assert PME#.			
7:2	Reserved.			
1:0	PowerState: power state. Read-write. Reset: 0. Specifies the current power state of the root port and sets the root port into a new power state.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	D0	10b	Reserved.
	01b	Reserved	11b	D3hot

D14F2x60 MSI Capability

Bits	Description
31:24	Reserved.
23	Msi64bit: MSI 64 bit capability. Read-only. Reset: 1. 1=The device is capable of sending 64-bit MSI messages.
22:20	MsiMultiEn: MSI multiple message enable. Read-write. Reset: 000b. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector.
19:17	MsiMultiCap: MSI multiple message capability. Read-only. Reset: 000b. 000b=The device is requesting one vector.
16	MsiEn: MSI enable. Read-write. Reset: 0. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.
15:8	NextPtr: next pointer. IF (D14F2x44[EnAFCap]) THEN Value: 70h. ELSE Value: 00h. ENDIF. Specifies the address of the next capability structure, or zero if this the end of the linked list of capability structures. See Table 91.
7:0	CapID: capability ID. IF (D14F2x44[EnMsiCap]==1) THEN Value: 05h. ELSE Value: 00h. ENDIF. 05h=MSI capability structure. See Table 91.

D14F2x64 MSI Message Address Low

Reset: 0000_0000h.

Bits	Description
31:2	MsiMsgAddrLo: MSI message address. Read-write. This register specifies the doubleword aligned address for the MSI memory write transaction.
1:0	Reserved.

D14F2x68 MSI Message Address High

Reset: 0000_0000h.

Bits	Description
31:8	Reserved.
7:0	MsiMsgAddrHi: MSI message address. Read-write. This register specifies the upper 8 bits of the MSI address in 64-bit MSI mode.

D14F2x6C MSI Message Data

Reset: 0000_0000h.

Bits	Description
31:16	Reserved.
15:0	MsiData: MSI message data. Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0.

D14F2x70 Advanced Features Capability

Bits	Description
31:26	Reserved.
25	TPCapabilities. Read-only. IF (D14F2x44[EnAFCap]==1) THEN Reset: 1. ELSE Reset: 0. ENDIF. 1=Support for Transactions Pending. See Table 91.
24	FLRCapabilities. Read-only. IF (D14F2x44[EnAFCap]==1) THEN Reset: 1. ELSE Reset: 0. ENDIF. 1=Support for Function Level Reset (FLR). See Table 91.
23:16	AFLength. Read-only. IF (D14F2x44[EnAFCap]==1) THEN Reset: 06h. ELSE Reset: 00h. ENDIF. Indicates AF Structure Length (bytes). See Table 91.
15:8	NextPtr: next pointer. Read-only. Reset: 00h. 00h=This the end of the linked list of capability structures. See Table 91.
7:0	AFCapID: capability ID. Read-only. IF (D14F2x44[EnAFCap]==1) THEN Reset: 13h. ELSE Reset: 00h. ENDIF. 13h=Indicates Advanced Features Capability. See Table 91.

D14F2x74 Advanced Features Control and Status

Bits	Description
31:9	Reserved.
8	TransactionPending. Read-only; updated-by-hardware. Reset: 0. 1=Indicates that the function has issued one or more non-posted transactions which have not been completed including non-posted transactions that a target has terminated with retry. 0=Indicates that all non-posted transactions have been completed.

7:1	Reserved.
0	InitiateFLR. RAZ; write-1-only; cleared-when-done. Reset: 0. A write of 1 initiates Function Level Reset. FLR requirements are defined in the PCI Express Base Specification. Registers and state information that do not apply to conventional PCI are exempt from the FLR requirements given there.

3.26.6 Secure Digital (SD) Controller

3.26.6.1 Device 14h Function 7 Configuration Registers (SD)

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D14F7x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: Device ID. Value: 7813h.
15:0	VendorID: Vendor ID. Value: 1022h. Specifies a unique 16-bit value assigned to a vendor.

D14F7x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; updated-by-hardware; write-1-to-clear. Reset: 0. 1=The FCH detects a parity error.
30	SignaledSystemError: Signaled System Error. Read; updated-by-hardware; write-1-to-clear. Reset: 0. SERR# status. 1=The FCH detects a PCI address parity error.
29	ReceivedMasterAbort: Received Master Abort. Read; updated-by-hardware; write-1-to-clear. Reset: 0. 1=The FCH acts as a PCI master and aborts a PCI bus memory cycle.
28	ReceivedTargetAbort: Received Target Abort. Read; updated-by-hardware; write-1-to-clear. Reset: 0. 1=FCH received Target Abort from a PCI target.
27	SignaledTargetAbort: Signaled Target Abort. Read; updated-by-hardware; write-1-to-clear. Reset: 0. 1=The FCH signaled Target Abort while acting as Bus Master.
26:25	DeviceSelectTiming: Device Select Timing. Value: 01b. 01b=DEVSEL# Medium timing when performing a positive decode.
24	MasterDataParityError: Master Data Parity Error. Read; updated-by-hardware; write-1-to-clear. Reset: 0. Data Parity reported. 1=The FCH detects PERR# asserted while acting as PCI master.
23:21	Reserved.
20	CapabilitiesList: Capabilities List. Value: 1.
19:10	Reserved.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Value: 0.
8	SERREnable: SERR# Enable. Read-write. Reset: 0. 1=FCH asserts SERR# when it detects as address parity error.
7	SteppingControl: Stepping Control. Value: 0. 1=Wait Cycle enable.
6	ParityErrorResponse: Parity Error Response. Read-write. Reset: 0. PERR# (Response) detection enable bit. 1=The FCH asserts PERR# when it is the agent receiving data and it detects a parity error. 0=PERR# is not asserted.
5	VGAPaletteSnoop: VGA Palette Snoop. Value: 0. 1=VGA Palette Snoop Enable. 0=Disable.
4	MemoryWriteandInvalidateEnable: Memory Write and Invalidate Enable. Value: 0. 1=Memory write and invalidate enable.
3	SpecialCycles: Special Cycles. Value: 0. 1=Special cycle recognition enable.

2	BusMaster: Bus Master. Read-write. Reset: 0. 1=Bus master function enable.
1	MemorySpace: Memory Space. Read-write. Reset: 0. 1=Enable memory access. 0=Disable.
0	IOSpace: IO Space. Value: 0. 1=IO access enable.

D14F7x08 Revision ID/Class Code

Bits	Description										
31:24	ClassCode: Class Code. Read-only. Reset: 8h. Basic Class.										
23:16	SubClass: Sub Class. Read-only. Reset: 5h. For SD host controller										
15:8	InterfaceCode: Interface Code. Value: 1. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Standard host not supporting DMA</td></tr> <tr> <td>01h</td><td>Standard host supporting DMA</td></tr> <tr> <td>02h</td><td>Vendor unique SD host controller</td></tr> <tr> <td>FFh-03h</td><td>Reserved</td></tr> </table>	Bits	Definition	00h	Standard host not supporting DMA	01h	Standard host supporting DMA	02h	Vendor unique SD host controller	FFh-03h	Reserved
Bits	Definition										
00h	Standard host not supporting DMA										
01h	Standard host supporting DMA										
02h	Vendor unique SD host controller										
FFh-03h	Reserved										
7:0	RevisionID: Revision ID. Value: 00h.										

D14F7x0C Cache Line Size

Bits	Description
31:24	Bist. Read-only. Reset: 0. No BIST modes.
23:16	HeaderType: Header Type. Read-only. Reset: 80h. Specifies the type of the predefined header in the configuration space.
15:8	LatencyTimer: Latency Timer. Read-only. Reset: 0. Specifies the value of the Latency Timer in units of PCICLKs.
7:0	CacheLineSize: Cache Line Size. Read-only. Reset: 0.

D14F7x10 Base Address Reg 0

Bits	Description
31:8	BaseAddress0: Base Address 0. Read-write. Reset: 0h. Specifies base address 0[31:8].
7:4	Reserved.
3	Prefetchable. Value: 0. 0=Non-prefetchable.
2:1	Type. Value: 10b. 00b=32-bit base address. 10b=64-bit base address.
0	SpaceIndicator: Space Indicator. Value: 0. 0=Memory-mapped base address.

D14F7x14 Upper Base Address Reg 0

Bits	Description
31:0	BaseAddress0Upper: Base Address 0 Upper. Read-write. Reset: 0. Specifies base address 0[63:32].

D14F7x2C Subsystem ID and Subsystem Vendor ID

Write-once. This 4-byte register is a write-once & read-only afterward register. The BIOS writes this register once (all 4 bytes at once) and software reads its value (when needed).

Bits	Description
31:16	SubsystemID: Subsystem ID. Reset: 7813h. Subsystem ID.
15:0	SubsystemVendorID: Subsystem Vendor ID. Reset: 1022h. Subsystem Vendor ID.

D14F7x34 Capabilities Pointer

Bits	Description
31:8	Reserved.
7:0	CapabilitiesPointer: Capabilities Pointer. Read-Only. Reset: 0.

D14F7x3C Interrupt Line

Bits	Description
31:16	Reserved.
15:8	InterruptPin: Interrupt Pin. Read-only. Reset: 1. Interrupt pin.
7:0	InterruptLine: Interrupt Line. Read-write. Reset: 0. Interrupt line.

D14F7x40 Slot Information

Bits	Description																				
31:7	Reserved.																				
6:4	NumberOfSlots: Number of Slots. Read-write. Reset: 0. Number of slots supported. These bits indicate the number of slots the Host Controller supports. In the case of a single function, a maximum of 6 slots can be assigned. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>1 slot</td><td>100b</td><td>5 slots</td></tr><tr><td>001b</td><td>2 slots</td><td>101b</td><td>6 slots</td></tr><tr><td>010b</td><td>3 slots</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>4 slots</td><td>111b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	1 slot	100b	5 slots	001b	2 slots	101b	6 slots	010b	3 slots	110b	Reserved	011b	4 slots	111b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	1 slot	100b	5 slots																		
001b	2 slots	101b	6 slots																		
010b	3 slots	110b	Reserved																		
011b	4 slots	111b	Reserved																		

3	Reserved.			
2:0	FirstBaseAddressRegisterNumber: First Base Address Register Number. Read-write. Reset: 0. Up to 6 base addresses can be specified in single configuration. These bits indicate the first base address register number assigned to SD Host Controller register set. In the case of single function and multiple register sets, contiguous base addresses are used. D14F7x40[NumberOfSlots] specifies the number of base addresses.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	Base Address 10h (BAR0)	100b	Base Address 20h (BAR4)
	001b	Base Address 14h (BAR1)	101b	Base Address 24h (BAR5)
	010b	Base Address 18h (BAR2)	110b	Reserved
	011b	Base Address 1Ch (BAR3)	111b	Reserved

D14F7x80 SD PCI MSI Capability Header

Bits	Description
31:24	Reserved.
23	ExtendAddrEn. Value: 1. 64-bit Address Capable.
22:20	MulMsgEn. Read-write. Reset: 0. Multiple Message Enable.
19:17	MulMsgCap. Read-only. Reset: 0. Multiple Message Capable.
16	MsiEnable. Read-write. Reset: 0. MSI Enable.
15:8	CapNxtPtr. Value: 0. Reset: 0.
7:0	CapId. Read-only. Reset: 5h. A value of 05h indicates MSI.

D14F7x84 SD PCI MSI Address

Bits	Description
31:2	MsgAddr. Read-write. Reset: 0. Specifies Message Address[31:2].
1:0	Reserved.

D14F7x88 SD PCI MSI Upper Address

Bits	Description
31:0	MsgUpperAddr. Read-write. Reset: 0. Specifies Message Upper Address[63:32].

D14F7x8C SD PCI MSI Data

Bits	Description
31:16	Reserved.
15:0	MsgData. Read-write. Reset: 0. Message Data.

D14F7x90 Power Management Capability Header

Bits	Description												
31:27	PMESupport: PME Support. Read-only. Reset: 0. This 5-bit field indicates the power states in which the function may assert PME#. A value of 0b for any bit indicates that the function is not capable of asserting the PME# signal while in that power state. <table> <tr> <td><u>Bit</u></td><td><u>Definition</u></td></tr> <tr> <td>[0]</td><td>PME# can be asserted from D0</td></tr> <tr> <td>[1]</td><td>PME# can be asserted from D1</td></tr> <tr> <td>[2]</td><td>PME# can be asserted from D2</td></tr> <tr> <td>[3]</td><td>PME# can be asserted from D3hot</td></tr> <tr> <td>[4]</td><td>PME# can be asserted from D3cold</td></tr> </table>	<u>Bit</u>	<u>Definition</u>	[0]	PME# can be asserted from D0	[1]	PME# can be asserted from D1	[2]	PME# can be asserted from D2	[3]	PME# can be asserted from D3hot	[4]	PME# can be asserted from D3cold
<u>Bit</u>	<u>Definition</u>												
[0]	PME# can be asserted from D0												
[1]	PME# can be asserted from D1												
[2]	PME# can be asserted from D2												
[3]	PME# can be asserted from D3hot												
[4]	PME# can be asserted from D3cold												
26	D2Support: D2 Support. Read-only. Reset: 0. 1=This function supports the D2 Power Management State.												
25	D1Support: D1 Support. Read-only. Reset: 0. 1=This function supports the D1 Power Management State.												
24:22	AuxCurrent: Aux Current. Read-only. Reset: 0. This 3 bit field reports the 3.3V auxiliary current requirements for the PCI function.												
21	Dsi. Read-only. Reset: 0. The Device Specific Initialization required. 1=Indicates special initialization of this function is required (beyond the standard PCI configuration header) before the generic class device driver is able to use it.												
20	Reserved.												
19	PmeClock: PME Clock. Value: 0. PME Clock. 0=Indicates that no PCI clock is required for the function to generate PME#. 1=Indicates that the function relies on the presence of the PCI clock for PME# operation.												
18:16	Version. Value: 011b. 011b=Indicates that this function complies with revision 1.2 of the PCI Power Management Interface Specification.												
15:8	CAPNextPointer: CAP Next Pointer. Read-only. Reset: 0. No other capability.												
7:0	CAPID: CAP ID. Read-only. Reset: 1. Power management.												

D14F7x94 Power Management Control and Status Register

Bits	Description
31:24	Data. Read-only. Reset: 0. Reports the state dependent data requested by the DataSelect field. The value of this register is scaled by the value reported by the DataScale field.
23	BPCCEn: Bus Power/Clock Control Enable. Read-only. Reset: 0. Bus Power/Clock Control Enable.
22	B2B3: B2 B3#. Read-only. Reset: 0. B2/B3 support for D3hot.
21:15	Reserved.
14:13	DataScale: Data Scale. Read-only. Reset: 0. Indicates the scaling factor to be used when interpreting the value of the Data register. The value and meaning of this field varies depending on which data value has been selected by the DataSelect field.
12:9	DataSelect: Data Select. Read-Write. Reset: 0. Selects which data is to be reported through the Data register and DataScale field.

8	PMEEEn: PME En. Read-Write. Reset: 0. 1=Enable the function to assert PME#. 0=PME# assertion is disabled.												
7:4	Reserved.												
3	NoSoftReset: No Soft Reset. Read-only. Reset: 0. 1=Indicates that devices transitioning from D3hot to D0 because of PowerState commands do not perform an internal reset.												
2	Reserved.												
1:0	Power. Read-only. Reset: 0. Determines the current power state of a function and to set the function into a new power state. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>D0</td><td>10b</td><td>D2</td></tr><tr><td>01b</td><td>D1</td><td>11b</td><td>D3hot</td></tr></table> If software attempts to write an unsupported, optional state to this field, the write operation must complete normally on the bus; however, the data is discarded and no state change occurs.	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	D0	10b	D2	01b	D1	11b	D3hot
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	D0	10b	D2										
01b	D1	11b	D3hot										

D14F7xB8 SD Auto Pattern

Bits	Description
31:28	SdDrvStr33Sn. Read-write. Reset: 0. Specifies the SN driver strength value for 3.3V.
27:24	SdDrvStr33Sp. Read-write. Reset: 0. Specifies the SP driver strength value for 3.3V.
23:0	Reserved.

3.26.6.2 SD Host Controller Configuration Registers (SDHC)

The registers are accessed directly mapped by [D14F7x10 \[Base Address Reg 0\]](#) and [D14F7x14 \[Upper Base Address Reg 0\]](#).

SDHC0x00 SDHC System Address / Argument 2

Bits	Description
31:16	SysAddr1. Read-write. Reset: 0. System Address upper bits. Updating this register clears DMA_WAIT. It indicates system memory address for DMA. When DMA transfer detects the DMA Buffer Boundary specified by the Host DMA Buffer Boundary in the Block Size register, SD controller asserts DMA_WAIT. Also SD controller generates DMA interrupt at this time when corresponding bits in the Normal Interrupt Status Enable register and Normal Interrupt Signal Enable register are set. While ADMA is enabled, this register is not be used.
15:0	SysAddr0. Read-write. Reset: 0. System Address lower bits. Updating this register clears DMA_WAIT.

SDHC0x04 SDHC Block CS

Block Size and Block Count.

Bits	Description
31:16	BlkCnt. Read-write. Reset: 0. Block Count. It indicates block count of multiple data transfer. It is enabled when the Block Count Enable bit (D01) in the Transfer Mode register is set to 1. It is decremented after each block data transmission. During infinite data transmission, setting this bit performs no function.

15	Reserved.			
14:12	DmaBufBndry. Read-write. Reset: 0. Host DMA Buffer Boundary. Indicates the contiguous buffer size in the system memory. When the boundary is reached, DMA interrupt will be generated.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	4K bytes	100b	64K bytes
	001b	8K bytes	101b	128K bytes
	010b	16K bytes	110b	256K bytes
	011b	32K bytes	111b	512K bytes
	11:0	BlkSize. Read-write. Reset: 0. Transfer Data Length (max. block size is 2K bytes). When the CE-ATA Enable bit of the CE-ATA Control register is set, a value of 0x000 indicates block size of 4K bytes.		

SDHC0x08 SDHC Command Argument

Bits	Description
31:16	ARGUMENT1. Read-write. Reset: 0. Upper bits. Command Argument. Command arguments specified as bits [39:8] of the command format.
15:0	ARGUMENT0. Read-write. Reset: 0. Lower bits.

SDHC0x0C SDHC Command/Transfer Mode

Bits	Description										
31:30	Reserved.										
29:24	CmdIdx. Read-write. Reset: 0. Command Index.										
23:22	CmdType. Read-write. Reset: 0. Command Type. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Normal.</td></tr> <tr> <td>01b</td><td>Suspend CMD52 for writing BR in CCCR.</td></tr> <tr> <td>10b</td><td>Resume CMD52 for writing Function Sel in CCCR.</td></tr> <tr> <td>11b</td><td>Abort CMD12 (SD Memory) or Abort CMD52 (SDIO).</td></tr> </table>	Bits	Definition	00b	Normal.	01b	Suspend CMD52 for writing BR in CCCR.	10b	Resume CMD52 for writing Function Sel in CCCR.	11b	Abort CMD12 (SD Memory) or Abort CMD52 (SDIO).
Bits	Definition										
00b	Normal.										
01b	Suspend CMD52 for writing BR in CCCR.										
10b	Resume CMD52 for writing Function Sel in CCCR.										
11b	Abort CMD12 (SD Memory) or Abort CMD52 (SDIO).										
21	DataPrsnt. Read-write. Reset: 0. Data Present Select. Indicates data is present and is transferred on the DAT line. When command is issued with this bit enabled, internal buffer is cleared. 0=No data. 1=Data.										
20	CmdIdxChkEn. Read-write. Reset: 0. 1=Command Index Check Enable. 0=Disable.										
19	CrcChkEn. Read-write. Reset: 0. 1=Command CRC Check Enable. 0=Disable.										
18	Reserved.										
17:16	RespType. Read-write. Reset: 0. Response Type Select. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>No Response.</td></tr> <tr> <td>01b</td><td>Response length is 136 bits.</td></tr> <tr> <td>10b</td><td>Response length is 48 bits without busy.</td></tr> <tr> <td>11b</td><td>Response length is 48 bits with busy.</td></tr> </table>	Bits	Definition	00b	No Response.	01b	Response length is 136 bits.	10b	Response length is 48 bits without busy.	11b	Response length is 48 bits with busy.
Bits	Definition										
00b	No Response.										
01b	Response length is 136 bits.										
10b	Response length is 48 bits without busy.										
11b	Response length is 48 bits with busy.										
15:6	Reserved.										
5	MultiBlk. Read-write. Reset: 0. 1=Multiple/Single Block Select. 0=Single Block.										

4	DataDir . Read-write. Reset: 0. Data Transfer Direction. 0=Write. 1=Read.										
3:2	AutoCmdEn . Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Auto Command Disabled</td></tr> <tr> <td>01b</td><td>Auto CMD12 Enable</td></tr> <tr> <td>10b</td><td>Auto CMD23 Enable</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Auto Command Disabled	01b	Auto CMD12 Enable	10b	Auto CMD23 Enable	11b	Reserved
Bits	Definition										
00b	Auto Command Disabled										
01b	Auto CMD12 Enable										
10b	Auto CMD23 Enable										
11b	Reserved										
1	BlkCntEn . Read-write. Reset: 0. 1=Block Count Enable.										
0	DmaEn . Read-write. Reset: 0. 1=DMA Enable. 0=Disable.										

SDHC0x10 SDHC_RESP1_0

Bits	Description
31:16	RESPONSE1 . Read-only. Reset: 0. R39-24 of response is saved in this register.
15:0	RESPONSE0 . Read-only. Reset: 0. R23-8 of response is saved in this register.

SDHC0x14 SDHC_RESP3_2

Bits	Description
31:16	RESPONSE3 . Read-only. Reset: 0. R71-56 of response is saved in this register.
15:0	RESPONSE2 . Read-only. Reset: 0. R55-40 of response is saved in this register.

SDHC0x18 SDHC_RESP5_4

Bits	Description
31:16	RESPONSE5 . Read-only. Reset: 0. R103-88 of response is saved in this register.
15:0	RESPONSE4 . Read-only. Reset: 0. R87-72 of response is saved in this register.

SDHC0x1C SDHC_RESP7_6

Bits	Description
31:16	RESPONSE7 . Read-only. Reset: 0. R127-120 of response or R39-24 of Auto CMD12 response is saved in this register.
15:0	RESPONSE6 . Read-only. Reset: 0. R119-104 of response or R23-8 of Auto CMD12 response is saved in this register.

SDHC0x20 SDHC_BUFFER

Bits	Description
31:16	BuffData1 . Read-write. Reset: 0. Upper bits. Data Buffer. Data will be accessed through this register. Data which exceeds the size designated by the Block Size register is not be written in the data buffer.
15:0	BuffData0 . Read-write. Reset: 0. Lower bits.

SDHC0x24 SDHC_PRSENT_STATE

Bits	Description
31:25	Reserved.
24	CmdLevel. Read-only. Reset: 0. CMD Line Signal Level. Reflects signal level of CMD line.
23:20	DatLevel. Read-only. Reset: 0. DAT Line Signal Level. Reflects signal level of DAT line.
19	WpLevel. Read-only. Reset: 0. Write Protect Switch Level. 0=Write protected. 1=Write enable.
18	CdLevel. Read-only. Reset: 0. Card Detect Pin Level. 0=No card present. 1=Card present.
17	CardStable. Read-only. Reset: 0. Card State Stable. Indicates Card Detect signal level is stable. 0=Not stable (debouncing or resetting). 1=Card stable.
16	CardIns. Read-only. Reset: 0. Card Inserted. 0=No card inserted or debouncing state or resetting. 1=Card inserted.
15:12	Reserved.
11	BufRdEn. Read-only. Reset: 0. Buffer Read Enable. Indicates buffer is ready for reading. 0=Read disable. 1=Read enable.
10	BufWrEn. Read-only. Reset: 0. Buffer Write Enable. Indicates buffer is ready for writing. 0=Write disable. 1=Write enable.
9	RdTxActive. Read-only. Reset: 0. Read Transfer Active. Indicates occurrence of read data transfer. 0=No data transferring. 1=Read data transferring.
8	WrTxActive. Read-only. Reset: 0. Write Transfer Active. Indicates occurrence of write data transfer. 0=No data transferring. 1=Write data transferring.
7:3	Reserved.
2	DatLineActive. Read-only. Reset: 0. DAT Line Active. Indicates DAT line on SD Bus is active. 0=DAT line inactive. 1=DAT line active.
1	CmdInhibDat. Read-only. Reset: 0. Command Inhibit (DAT). Indicates that commands which use also the DAT line can be issued. 0=Can issue commands which use DAT line. 1=Cannot issue any commands which use DAT line.
0	CmdInhibCmd. Read-only. Reset: 0. Command Inhibit (CMD). Indicates that commands which use only the CMD line can be issued. 0=Can issue commands which use CMD line. 1=Cannot issue any commands.

SDHC0x28 SDHC_CTRL1

Bits	Description
31:27	Reserved.
26	SdRemWakeEn. Read-write. Reset: 0. 1=SD Card Removal Wake up. 0=Disable.
25	SdInsWakeEn. Read-write. Reset: 0. 1=SD Card Insertion Wake up. 0=Disable.
24	SdIntWakeEn. Read-write. Reset: 0. 1=SD Card Interrupt Wake up. 0=Disable.
23:20	Reserved.
19	BgIntEn. Read-write. Reset: 0. Interrupt at Block Gap. 1=Enable interrupt detection during 4-bit block transmission. 0=Disable.

18	ReadWaitEn. Read-write. Reset: 0. Read Wait Control. 1=Indicates Read Wait will be inserted when needed. 0=Disable.															
17	ContReq. Read-write. Reset: 0. Continue Request. Writing 1 to this bit triggers restart of halted data transaction with current register setting. Once this bit is 1, the internal buffer will be cleared and data transfer sequence will be restarted. 1=Restart.															
16	BgStopReq. Read-write. Reset: 0. Stop at Block Gap Request. Writing 1 to this bit triggers halting of current data transfer after next block gap. To use this request, the Read Wait function is necessary in read transaction. Even if the Auto CMD12 Enable bit is set to 1, Auto CMD12 is not issued in case this bit is set to 1. This bit is cleared by not only writing 0 to this bit, but also issuing abort commands. 0=Transfer. 1=Stop.															
15:12	Reserved.															
11:9	SdBusVoltage. Read-write. Reset: 0. SD Bus Voltage. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>100b-000b</td><td>Reserved</td><td>110b</td><td>3.0 Volts</td></tr><tr><td>101b</td><td>1.8 Volts</td><td>111b</td><td>3.3 Volts</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	100b-000b	Reserved	110b	3.0 Volts	101b	1.8 Volts	111b	3.3 Volts
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>													
100b-000b	Reserved	110b	3.0 Volts													
101b	1.8 Volts	111b	3.3 Volts													
8	SdBusEn. Read-write. Reset: 0. SD Bus Power. Automatically cleared when card is removed. 0=Off. 1=On.															
7	CdTestEn. Read-write. Reset: 0. Card Detect Signal Selection. 0=I/O pin. 1=SD_TEST_LEVEL.															
6	CdTestLevel. Read-write. Reset: 0. Card Detect Test Level. 0=Card removed. 1=Card inserted.															
5	MmcWidth. Read-write. Reset: 0. Extended Data Transfer Width (MMC). 0=Use width set by DAT_TX_WIDTH. 1=Force 8-bit.															
4:3	DmaSelect. Read-write. Reset: 0. DMA Select. Valid only when DMA is enabled. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>No DMA or SDMA selected</td><td>10b</td><td>32-bit ADMA2</td></tr><tr><td>01b</td><td>32-bit ADMA</td><td>11b</td><td>64-bit ADMA2</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	No DMA or SDMA selected	10b	32-bit ADMA2	01b	32-bit ADMA	11b	64-bit ADMA2
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>													
00b	No DMA or SDMA selected	10b	32-bit ADMA2													
01b	32-bit ADMA	11b	64-bit ADMA2													
2	HighSpeedEn. Read-write. Reset: 0. High Speed Enable. When disabled, SD controller outputs commands and data on the falling edge of the SD clock. (Up to 25 MHz SD clock can be supported.)When enabled, SD controller outputs commands and data on the rising edge of the SD clock. (Up to 50 MHz SD clock can be supported.) 0=Normal speed. 1=High speed.															
1	DatTxWidth. Read-write. Reset: 0. Data Transfer Width. 0=1-bit. 1=4-bit.															
0	LedCtrl. Read-write. Reset: 0. LED control. 1=Drives the LED_ON output. 0=Off.															

SDHC0x2C SDHC_CTRL2

Bits	Description
31:27	Reserved.
26	SoftRstDat. Read-write. Reset: 0. Software Reset for DAT Line. The following registers will be cleared: SDHC0x20 [BufData1, BufData0], SDHC0x24 [BufRdEn, BufWrEn, RdTxActive, WrTxActive, DatLineActive, CmdInhibDat], SDHC0x28 [ContReq, BgStopReq], SDHC0x30 [BufRdRdy, BufWrRdy, BlockGapEvt, DatDone].
25	SoftRstCmd. Read-write. Reset: 0. Software Reset for CMD Line. The following registers will be cleared: SDHC0x24 [CmdInhibCmd], SDHC0x30 [CmdDone].

24	SoftRstAll. Read-write. Reset: 0. Software Reset for All. The following registers will not be cleared:- CMD Line Signal Level- DAT[3:0] Line Signal Level- Write Protect Switch Pin Level- Card Detect Pin Level- Card State Stable- Card Inserted- all bits in the Capabilities Register- all bits in the Maximum Current Capabilities Register.																																	
23:20	Reserved.																																	
19:16	DataToCnt. Read-write. Reset: 0. Data Timeout Counter Value. By using this counter value, DAT line timeouts are detected. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>Eh-0h</td><td>2^(DataToCnt+13)</td><td>Fh</td><td>Reserved.</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	Eh-0h	2^(DataToCnt+13)	Fh	Reserved.																						
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																															
Eh-0h	2^(DataToCnt+13)	Fh	Reserved.																															
15:8	SdclkDiv[7:0]. Read-write. Reset: 0. SDCLK Frequency Select. If multiple bits are set, the most significant bit will be selected. Host Controller Version 1.00 and 2.00: <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>0000_0000b</td><td>Divide by 1.</td><td>0001_xxxxb</td><td>Divide by 32</td></tr><tr><td>0000_0001b</td><td>Divide by 2.</td><td>001x_xxxxb</td><td>Divide by 64.</td></tr><tr><td>0000_001xb</td><td>Divide by 4.</td><td>01xx_xxxxb</td><td>Divide by 128.</td></tr><tr><td>0000_01xxb</td><td>Divide by 8.</td><td>1xxx_xxxxb</td><td>Divide by 256.</td></tr><tr><td>0000_1xxxb</td><td>Divide by 16.</td><td></td><td></td></tr></table> Host Controller Version 3.00: <table><tr><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>3FFh-001h</td><td>Divide by 1/(2*SdclkDiv[9:0])</td></tr><tr><td>000h</td><td>Divide by 1</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	0000_0000b	Divide by 1.	0001_xxxxb	Divide by 32	0000_0001b	Divide by 2.	001x_xxxxb	Divide by 64.	0000_001xb	Divide by 4.	01xx_xxxxb	Divide by 128.	0000_01xxb	Divide by 8.	1xxx_xxxxb	Divide by 256.	0000_1xxxb	Divide by 16.			<u>Bits</u>	<u>Definition</u>	3FFh-001h	Divide by 1/(2*SdclkDiv[9:0])	000h	Divide by 1
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																															
0000_0000b	Divide by 1.	0001_xxxxb	Divide by 32																															
0000_0001b	Divide by 2.	001x_xxxxb	Divide by 64.																															
0000_001xb	Divide by 4.	01xx_xxxxb	Divide by 128.																															
0000_01xxb	Divide by 8.	1xxx_xxxxb	Divide by 256.																															
0000_1xxxb	Divide by 16.																																	
<u>Bits</u>	<u>Definition</u>																																	
3FFh-001h	Divide by 1/(2*SdclkDiv[9:0])																																	
000h	Divide by 1																																	
7:6	SdclkDiv[9:8]. Read-write. Reset: 0.																																	
5	ClkGenSel: Clock Generator Select. Read-write. Reset: 0. 1=Programmable Clock Mode. 0=Divided Clock Mode.																																	
4:3	Reserved.																																	
2	SdclkEn. Read-write. Reset: 0. SD Clock Enable. SDCLK Frequency Select can be changed when this bit is 0. When card is removed, this bit is cleared to 0 automatically. 0=Disable. 1=Enable.																																	
1	SysclkStable. Read-only. Reset: 0. Internal Clock Stable. 0=Unstable. 1=Stable.																																	
0	SysclkEn. Read-write. Reset: 0. 1= Internal Clock Enable. 0=Disable.																																	

SDHC0x30 SDHC_INT_STATUS

Bits	Description
31:30	Reserved.
29	CeAtaErr. Read; Write-1-to-clear. Reset: 0. CE-ATA Error.
28	SdmaErr. Read; Write-1-to-clear. Reset: 0. SDMA Error.
27	Reserved.
26	TuningError. Read; Write-1-to-clear. Reset: 0. 1=An unrecoverable tuning error is detected in a during the tuning procedure.
25	AdmaErr. Read; Write-1-to-clear. Reset: 0. ADMA Error.
24	Acmd12Err. Read; Write-1-to-clear. Reset: 0. Auto CMD12 Error. Logical OR of Auto CMD12 Error Status Register.
23	Reserved.

22	DatEndErr. Read; Write-1-to-clear. Reset: 0. Data CRC Error.
21	DatCrcErr. Read; Write-1-to-clear. Reset: 0. Data CRC Error.
20	DatToErr. Read; Write-1-to-clear. Reset: 0. Data Timeout Error.
19	CmdIdxErr. Read; Write-1-to-clear. Reset: 0. Command Index Error. Mismatch of Command Index and index of response.
18	CmdEndErr. Read; Write-1-to-clear. Reset: 0. Command End Bit Error.
17	CmdCrcErr. Read; Write-1-to-clear. Reset: 0. Command CRC Error. If both CMD_TO_ERR and CMD_CRC_ERR are set, this indicates Command Conflict Error.
16	CmdToErr. Read; Write-1-to-clear. Reset: 0. Command Timeout Error. Response not returned within 128 SDCLK cycles.
15	Error. Read; Write-1-to-clear. Reset: 0. Error Interrupt.
14:13	Reserved.
12	ReTuningEvent. Read-only. Reset: 0. 1=Re-tuning should be performed.
11:9	Reserved.
8	Sdio. Read; Write-1-to-clear. Reset: 0. SDIO Card Interrupt. Writing 1 to this register does not clear this bit. To clear this bit, interrupt factor of SDIO cards should be cleared. The value of this bit is latched internally as long as the Card Interrupt bit (D08) in the Normal Interrupt Status Enable register is 1.
7	CardRem. Read; Write-1-to-clear. Reset: 0. Card Removal.
6	CardIns. Read; Write-1-to-clear. Reset: 0. Card Insertion.
5	BufRdRdy. Read; Write-1-to-clear. Reset: 0. Buffer Read Ready. In the case where Auto CMD12 is enabled and last block has been transferred, Auto CMD12 will be issued prior to this bit being set to 1. Clearing this bit should be done before buffer reading, because SD controller has dual buffer and the next Buffer Read Ready interrupt may occur immediately.
4	BufWrRdy. Read; Write-1-to-clear. Reset: 0. Buffer Write Ready. Clearing this bit should be done before buffer writing, because the SD controller has dual buffer and the next Buffer Write Ready interrupt may occur immediately.
3	DmaEvt. Read; Write-1-to-clear. Reset: 0. DMA Interrupt. It is set when internal counter reaches the value designated by Host DMA Buffer Boundary. It should be cleared by Host Driver after System Address Register is updated.
2	BlockGapEvt. Read; Write-1-to-clear. Reset: 0. Block Gap Event. It indicates the timing of next block gap, which was requested by the Stop At Block Gap Request. In case of write transaction, this interrupt will be generated before busy completion.
1	DatDone. Read; Write-1-to-clear. Reset: 0. Data Transfer Complete. Indicates the timing for completion of data transaction, which includes the completion at the block gap by the Stop At Block Gap Request. When some errors are detected during data transaction, this bit will not be set. In the case where Auto CMD12 is enabled, Auto CMD12 will be issued prior to this bit being set to 1.
0	CmdDone: cmdDone (r). Read-write. Reset: 0. Command Complete. The end bit of the command response is received. In the case of commands with no response, the end of the command.

SDHC0x34 SDHC_INT_MASK

Bits	Description
31:30	Reserved.
29	CeAtaErrMask. Read-write. Reset: 0. CE-ATA Error. 0=Masked. 1=Enable.
28	SdmaErrMask. Read-write. Reset: 0. SDMA Error. 0=Masked. 1=Enable.
27	Reserved.
26	TuningErrorStatusEnable. Read-write. Reset: 0. 1=Tuning Event Status Enable. 0=Masked.
25	AdmaErrMask. Read-write. Reset: 0. ADMA Error. 0=Masked. 1=Enable.
24	Acmd12ErrMask. Read-write. Reset: 0. Auto CMD12 Error. 0=Masked. 1=Enable.
23	CurLimErrMask. Read-write. Reset: 0. Current Limit Error. 0=Masked. 1=Enable.
22	DatEndErrMask. Read-write. Reset: 0. Data End Bit Error. 0=Masked. 1=Enable.
21	DatCrcErrMask. Read-write. Reset: 0. Data CRC Error. 0=Masked. 1=Enable.
20	DatToErrMask. Read-write. Reset: 0. Data Timeout Error. 0=Masked. 1=Enable.
19	CmdIdxErrMask. Read-write. Reset: 0. Command Index Error. 0=Masked. 1=Enable.
18	CmdEndErrMask. Read-write. Reset: 0. Command End Bit Error. 0=Masked. 1=Enable.
17	CmdCrcErrMask. Read-write. Reset: 0. Command CRC Error. 0=Masked. 1=Enable.
16	CmdToErrMask. Read-write. Reset: 0. Command Timeout Error. 0=Masked. 1=Enable.
15:13	Reserved.
12	ReTuningEventStatusEn. Read-write. Reset: 0. 1=Re-Tuning Event Status Enable. 0=Masked.
11:9	Reserved.
8	SdioMask. Read-write. Reset: 0. Card Interrupt. 0=Masked. 1=Enable.
7	CardRemMask. Read-write. Reset: 0. Card Removal. 0=Masked. 1=Enable.
6	CardInsMask. Read-write. Reset: 0. Card Insertion. 0=Masked. 1=Enable.
5	BufRdRdyMask. Read-write. Reset: 0. Buffer Read Ready. 0=Masked. 1=Enable.
4	BufWrRdyMask. Read-write. Reset: 0. Buffer Write Ready. 0=Masked. 1=Enable.
3	DmaEvtMask. Read-write. Reset: 0. DMA Interrupt. 0=Masked. 1=Enable.
2	BlockGapEvtMask. Read-write. Reset: 0. Block Gap Event. 0=Masked. 1=Enable.
1	DatDoneMask. Read-write. Reset: 0. Transfer Complete. 0=Masked. 1=Enable.
0	CmdDoneMask. Read-write. Reset: 0. Command Complete. 0=Masked. 1=Enable.

SDHC0x38 SDHC_SIG_MASK

Bits	Description
31:30	Reserved.
29	CeAtaErrEn. Read-write. Reset: 0. CE-ATA Error. 0=Masked. 1=Enable.
28	SdmaErrEn. Read-write. Reset: 0. SDMA Error. 0=Masked. 1=Enable.
27	Reserved.
26	TuningErrorStatusEnable. Read-write. Reset: 0. 1=Tuning Event Status Enable. 0=Masked.

25	AdmaErrEn. Read-write. Reset: 0. ADMA Error. 0=Masked. 1=Enable.
24	Acmd12ErrEn. Read-write. Reset: 0. Auto CMD12 Error. 0=Masked. 1=Enable.
23	CurLimErrEn. Read-write. Reset: 0. Current Limit Error. 0=Masked. 1=Enable.
22	DatEndErrEn. Read-write. Reset: 0. Data End Bit Error. 0=Masked. 1=Enable.
21	DatCrcErrEn. Read-write. Reset: 0. Data CRC Error. 0=Masked. 1=Enable.
20	DatToErrEn. Read-write. Reset: 0. Data Timeout Error. 0=Masked. 1=Enable.
19	CmdIdxErrEn. Read-write. Reset: 0. Command Index Error. 0=Masked. 1=Enable.
18	CmdEndErrEn. Read-write. Reset: 0. Command End Bit Error. 0=Masked. 1=Enable.
17	CmdCrcErrEn. Read-write. Reset: 0. Command CRC Error. 0=Masked. 1=Enable.
16	CmdToErrEn. Read-write. Reset: 0. Command Timeout Error. 0=Masked. 1=Enable.
15:13	Reserved.
12	ReTuningEventStatusEn. Read-write. Reset: 0. 1=Re-Tuning Event Status Enable. 0=Masked.
11:9	Reserved.
8	SdioEn. Read-write. Reset: 0. Card Interrupt. 0=Masked. 1=Enable.
7	CardRemEn. Read-write. Reset: 0. Card Removal. 0=Masked. 1=Enable.
6	CardInsEn. Read-write. Reset: 0. Card Insertion. 0=Masked. 1=Enable.
5	BufRdRdyEn. Read-write. Reset: 0. Buffer Read Ready. 0=Masked. 1=Enable.
4	BufWrRdyEn. Read-write. Reset: 0. Buffer Write Ready. 0=Masked. 1=Enable.
3	DmaEvtEn. Read-write. Reset: 0. DMA Interrupt. 0=Masked. 1=Enable.
2	BlockGapEvtEn. Read-write. Reset: 0. Block Gap Event. 0=Masked. 1=Enable.
1	DatDoneEn. Read-write. Reset: 0. Transfer Complete. 0=Masked. 1=Enable.
0	CmdDoneEn. Read-write. Reset: 0. Command Complete. 0=Masked. 1=Enable.

SDHC0x3C SDHC ACMD12 Error/Host Control 2

Bits	Description												
31	PresetValEn. Read-write. Reset: 0. 1=Enable automatic selection of Preset Value. 0=SDCLK and driver strength are controlled by Host Driver.												
30	AsyncIntEn. Read-write. Reset: 0. Enable Asynchronous Interrupts.												
29:24	Reserved.												
23	SamplingClkSel. Read-write. Reset: 0. 1=Tuned clock is used to sample data. 0=Fixed clock is used to sample data.												
22	ExecTuning. Read-write; cleared-when-done. Reset: 0. 1=Execute Tuning. 0=Not Tuned or Tuning Completed.												
21:20	DvrStrengthSel. Read-write. Reset: 0. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>Driver Type B is Selected (Default)</td><td>10b</td><td>Driver Type C is Selected</td></tr><tr><td>01b</td><td>Driver Type A is Selected</td><td>11b</td><td>Driver Type D is Selected</td></tr></table>	Bits	Definition	Bits	Definition	00b	Driver Type B is Selected (Default)	10b	Driver Type C is Selected	01b	Driver Type A is Selected	11b	Driver Type D is Selected
Bits	Definition	Bits	Definition										
00b	Driver Type B is Selected (Default)	10b	Driver Type C is Selected										
01b	Driver Type A is Selected	11b	Driver Type D is Selected										
19	En_1_8VSignaling. Read-write. Reset: 0. 1=1.8 Volt Signaling. 0=3.3 Volt Signaling.												

18:16	UHS_ModeSel. Read-write. Reset: 0. Select UHS-I mode when (En_1_8VSignaling==1).			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	SDR12	011b	SDR104
	001b	SDR25	100b	DDR50
	010b	SDR50	111b-101b	Reserved
15:8	Reserved.			
7	CmdErr. Read-only. Reset: 0. Command Not Issued By Auto CMD12 Error.			
6:5	Reserved.			
4	IndexErr. Read-only. Reset: 0. Auto CMD12 Index Error.			
3	EndErr. Read-only. Reset: 0. Auto CMD12 End Bit Error.			
2	CrcErr. Read-only. Reset: 0. Auto CMD12 CRC Error.			
1	ToErr. Read-only. Reset: 0. Auto CMD12 Timeout Error.			
0	ExeErr. Read-only. Reset: 0. Auto CMD12 Not Executed Error.			

SDHC0x40 SDHC_CAPABILITY

Bits	Description			
31:30	SlotType. Read-only. Reset: 0.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Removable Card Slot	10b	Shared Bus Slot
	01b	Embedded Slot for One Device	11b	Reserved.
29	AsynIntSup: Asynchronous Interrupt Support. Read-only. Reset: 1. 1=Asynchronous interrupt supported. 0=Asynchronous interrupt not supported.			
28	Support64BitSystemBus. Read-only. Reset: 0. 1=Host Controller supports 64-bit address descriptor mode and 64-bit address system bus.			
27	Reserved.			
26	Support18v. Read-only. Reset: 1. 1=Voltage Support for 1.8V.			
25	Support30v. Read-only. Reset: 0. 1=Voltage Support for 3.0V.			
24	Support33v. Read-only. Reset: 1. 1=Voltage Support for 3.3V.			
23	SusResSupport. Read-only. Reset: 1. 1=Suspend and Resume is supported.			
22	DmaSupport. Read-only. Reset: 1. 1=DMA is supported.			
21	HiSpeedSupport. Read-only. Reset: 1. 1=High Speed is supported.			
20	AdmaSupport. Read-only. Reset: 1. 1=Advanced DMA is supported.			
19	Adma2Support. Read-only. Reset: 1. 1=Advanced DMA2 is supported.			
18	Mmc8Support. Read-only. Reset: 0. Extended Media Bus Support (MMC).			
17:16	MaxBlkLen. Read-only. Reset: 2h. Specifies the maximum block size that the Host Driver can read and write to the buffer in the Host Controller. The buffer shall transfer this block size without wait cycles.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	512 bytes	10b	2048 bytes
	01b	1024 bytes	11b	Reserved

15:8	BaseClkFreq. Read-only. Reset: 32h. Specifies the base clock frequency for SD Clock. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>FFh-01h</td><td><BaseClkFreq> MHz</td></tr> </table>	Bits	Definition	00h	Reserved	FFh-01h	<BaseClkFreq> MHz
Bits	Definition						
00h	Reserved						
FFh-01h	<BaseClkFreq> MHz						
7	TmoClkUnit: Timeout Clock Unit. Read-only. Reset: 1. Specifies the unit of TmoClkFreq. 0=Unit is KHz. 1=Unit is MHz.						
6	Reserved.						
5:0	TmoClkFreq: Timeout Clock Frequency. Read-only. Reset: 32h. Specifies the base clock frequency used to detect Data Timeout Error. TmoClkUnit defines the unit of this field's value.						

SDHC0x44 SDHC_CAPABILITY 2

Bits	Description												
31:24	Reserved.												
23:16	ClockMultiplier. Read-only. Reset: 3. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>ClockMultiplier not supported.</td></tr> <tr> <td>FFh-01h</td><td><ClockMultiplier+1> MHz</td></tr> </table>	Bits	Definition	00h	ClockMultiplier not supported.	FFh-01h	<ClockMultiplier+1> MHz						
Bits	Definition												
00h	ClockMultiplier not supported.												
FFh-01h	<ClockMultiplier+1> MHz												
15:14	ReTuningModes. Read-only. Reset: 0. Specifies re-tuning method and limits the maximum data length. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Mode 1, Timer, 4 MBMax Data length.</td></tr> <tr> <td>01b</td><td>Mode 2, Timer and Re-Tuning Request, 4 MBMax Data length.</td></tr> <tr> <td>10b</td><td>Mode 3, Auto Re-Tuning (for transfer)Timer and Re-Tuning Request, any Data Length.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	Mode 1, Timer, 4 MBMax Data length.	01b	Mode 2, Timer and Re-Tuning Request, 4 MBMax Data length.	10b	Mode 3, Auto Re-Tuning (for transfer)Timer and Re-Tuning Request, any Data Length.	11b	Reserved.		
Bits	Definition												
00b	Mode 1, Timer, 4 MBMax Data length.												
01b	Mode 2, Timer and Re-Tuning Request, 4 MBMax Data length.												
10b	Mode 3, Auto Re-Tuning (for transfer)Timer and Re-Tuning Request, any Data Length.												
11b	Reserved.												
13	UseTuningForSDR50. Read-only. Reset: 0. 1=SDR50 requires tuning.												
12	Reserved.												
11:8	TimerCountForReTuning. Read-only. Reset: 5. Specifies value of the Re-Tuning Timer for Re-Tuning Mode 1 to 3. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Re-tuning timer disabled.</td></tr> <tr> <td>1h</td><td>1 Second</td></tr> <tr> <td>Bh-2h</td><td><2^(TimerCountForReTuning-1)> Seconds</td></tr> <tr> <td>Eh-Ch</td><td>Reserved</td></tr> <tr> <td>Fh</td><td>Get information from other source.</td></tr> </table>	Bits	Definition	0h	Re-tuning timer disabled.	1h	1 Second	Bh-2h	<2^(TimerCountForReTuning-1)> Seconds	Eh-Ch	Reserved	Fh	Get information from other source.
Bits	Definition												
0h	Re-tuning timer disabled.												
1h	1 Second												
Bh-2h	<2^(TimerCountForReTuning-1)> Seconds												
Eh-Ch	Reserved												
Fh	Get information from other source.												
7	Reserved.												
6	DriverTypeDSupport. Read-only. Reset: 0. 1=Support of Driver Type D for 1.8 Signaling.												
5	DriverTypeCSupport. Read-only. Reset: 0. 1=Support of Driver Type C for 1.8 Signaling.												
4	DriverTypeASupport. Read-only. Reset: 0. 1=Support of Driver Type A for 1.8 Signaling.												
3	Reserved.												

2	DDR50Support. Read-only. Reset: 0. 1=DDR50 is supported.
1:0	SDRSupport. Read-only. Reset: 3.
Bit	Definition
[0]	1=SDR50 is supported.
[1]	1=SDR104 is supported.

SDHC0x48 SDHC_CURR_CAPABILITY

Bits	Description
31:24	Reserved.
23:16	MaxCurr18v. Read-only. Reset: C8h. Max Current for 1.8V.
15:8	MaxCurr30v. Read-only. Reset: 0. Max Current for 3.0V.
7:0	MaxCurr33v. Read-only. Reset: 64h. Max Current for 3.3V.

SDHC0x50 SDHC_FORCE_EVT

Bits	Description
31:30	Reserved.
29	CeAtaErrFrc. Read-write. Reset: 0. Force CE-ATA Error.
28	SdmaErrFrc. Read-write. Reset: 0. Force SDMA Error.
27:26	Reserved.
25	AdmaErrFrc. Read-write. Reset: 0. Force ADMA Error.
24	Acmd12ErrFrc. Read-write. Reset: 0. Force Auto CMD12 Error.
23	CurLimErrFrc. Read-write. Reset: 0. Force Current Limit Error.
22	DatEndErrFrc. Read-write. Reset: 0. Force Data End Bit Error.
21	DatCrcErrFrc. Read-write. Reset: 0. Force Data CRC Error.
20	DatToErrFrc. Read-write. Reset: 0. Force Data Timeout Error.
19	CmdIdxErrFrc. Read-write. Reset: 0. Force Command Index Error.
18	CmdEndErrFrc. Read-write. Reset: 0. Force Command End Bit Error.
17	CmdCrcErrFrc. Read-write. Reset: 0. Force Command CRC Error.
16	CmdToErrFrc. Read-write. Reset: 0. Force Command Timeout Error.
15:8	Reserved.
7	Acmd12CmdErrFrc. Read-write. Reset: 0. Force Command Not Issued By Auto CMD12 Error.
6:5	Reserved.
4	Acmd12IdxErrFrc. Read-write. Reset: 0. Force Auto CMD12 Index Error.
3	Acmd12EndErrFrc. Read-write. Reset: 0. Force Auto CMD12 End Bit Error.
2	Acmd12CrcErrFrc. Read-write. Reset: 0. Force Auto CMD12 CRC Error.
1	Acmd12ToErrFrc. Read-write. Reset: 0. Force Auto CMD12 Timeout Error.
0	Acmd12ExeErrFrc. Read-write. Reset: 0. Force Auto CMD12 Not Executed Error.

SDHC0x54 SDHC_ADMA_ERR

Bits	Description										
31:3	Reserved.										
2	AddrLenMismatch . Read-only. Reset: 0. ADMA Address Length Mismatch Error. This error occurs in the following 2 cases:1. While Block Count Enable being set, the total data length specified by the descriptor table is different from that specified by the Block Count and Block Length.2. Total data length cannot be divided by the block length.										
1:0	AdmaState . Read-only. Reset: 0. ADMA State when error has occurred. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Stop DMA</td></tr> <tr> <td>01b</td><td>Fetch Descriptor.</td></tr> <tr> <td>10b</td><td>Change Address.</td></tr> <tr> <td>11b</td><td>Transfer Data.</td></tr> </table>	Bits	Definition	00b	Stop DMA	01b	Fetch Descriptor.	10b	Change Address.	11b	Transfer Data.
Bits	Definition										
00b	Stop DMA										
01b	Fetch Descriptor.										
10b	Change Address.										
11b	Transfer Data.										

SDHC0x58 SDHC_ADMA_SAD

Bits	Description
31:16	AdmaSysAddr1 . Read-write. Reset: 0. Upper bits. ADMA System Address. Before ADMA data transfer, the descriptor address should be set by the Host Driver. This address needs to be set with 4-byte alignment, since the descriptor table has 32-bit (4 byte) information formatted.
15:0	AdmaSysAddr0 . Read-write. Reset: 0. Lower bits.

SDHC0x6[C:0:step4] Preset ValueTable 260: [Register Mapping](#) for SDHC0x6[C:0:step4]

Register	Function
SDHC0x60	Initialization 3.3V or 1.8V/Default Speed 3.3V
SDHC0x64	High Speed 3.3V/SDR12 1.8V Preset Values
SDHC0x68	SDR25 1.8V/SDR50 1.8V Preset Values
SDHC0x6C	SDR104 1.8V/DDR50 1.8V Preset Values

Table 261: [Field Mapping](#) for SDHC0x6[C:0:step4]

Register	Bits					
	31:30	26	25:16	15:14	10	9:0
SDHC0x60	DefaultSpeed	DefaultSpeed	DefaultSpeed	Initialization	Initialization	Initialization
SDHC0x64	SDR12	SDR12	SDR12	HighSpeed	HighSpeed	HighSpeed
SDHC0x68	SDR50	SDR50	SDR50	SDR25	SDR25	SDR25
SDHC0x6C	DDR50	DDR50	DDR50	SDR104	SDR104	SDR104

Bits	Description
31:30	DvrStrengthSelPreset1 . See: DvrStrengthSelPreset0.

29:27	Reserved.			
26	ClkGenSelPreset1. See: ClkGenSelPreset0.			
25:16	SdClkFreqSel1. See: SdClkFreqSel0.			
15:14	DvrStrengthSelPreset0. Read-only. Driver Strength is supported by 1.8V signaling bus speed modes. Does not apply for 3.3V signaling. See SDHC0x3C[DvrStrengthSel] .			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Driver Type B is Selected	10b	Driver Type C is Selected
	01b	Driver Type A is Selected	11b	Driver Type D is Selected
13:11	Reserved.			
10	ClkGenSelPreset0. Read-only. Clock Generator Select Value. See SDHC0x2C[ClkGenSel] . 1=Programmable Clock Generator. 0=Host Controller Ver2.00 Compatible Clock Generator.			
9:0	SdClkFreqSel0. Read-only. A10-bit preset value. See SDHC0x2C[SdclkDiv[9:0]] .			

SDHC0xE0 Shared Bus Control Register

Bits	Description																				
31	Reserved.																				
30:24	BackEndPwrCtrl: Back-End Power Control. Read-write. Reset: 0. 0=Back-end power is off. 1=Back-end power is supplied. <table><tr><th><u>Bit</u></th><th><u>Definition</u></th></tr><tr><td>[0]</td><td>Back-end Power Control for Device 1</td></tr><tr><td>[1]</td><td>Back-end Power Control for Device 2</td></tr><tr><td>[2]</td><td>Back-end Power Control for Device 3</td></tr><tr><td>[3]</td><td>Back-end Power Control for Device 4</td></tr><tr><td>[4]</td><td>Back-end Power Control for Device 5</td></tr><tr><td>[5]</td><td>Back-end Power Control for Device 6</td></tr><tr><td>[6]</td><td>Back-end Power Control for Device 7</td></tr></table>	<u>Bit</u>	<u>Definition</u>	[0]	Back-end Power Control for Device 1	[1]	Back-end Power Control for Device 2	[2]	Back-end Power Control for Device 3	[3]	Back-end Power Control for Device 4	[4]	Back-end Power Control for Device 5	[5]	Back-end Power Control for Device 6	[6]	Back-end Power Control for Device 7				
<u>Bit</u>	<u>Definition</u>																				
[0]	Back-end Power Control for Device 1																				
[1]	Back-end Power Control for Device 2																				
[2]	Back-end Power Control for Device 3																				
[3]	Back-end Power Control for Device 4																				
[4]	Back-end Power Control for Device 5																				
[5]	Back-end Power Control for Device 6																				
[6]	Back-end Power Control for Device 7																				
23	Reserved.																				
22:20	IntPinSel. Read-write. Reset: 0. Selects interrupt pin inputs. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>Interrupt is detected by Interrupt Cycle</td><td>010b</td><td>INT_B is Enabled</td></tr><tr><td>001b</td><td>INT_A is Enabled</td><td>100b</td><td>INT_C is Enabled</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	Interrupt is detected by Interrupt Cycle	010b	INT_B is Enabled	001b	INT_A is Enabled	100b	INT_C is Enabled								
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	Interrupt is detected by Interrupt Cycle	010b	INT_B is Enabled																		
001b	INT_A is Enabled	100b	INT_C is Enabled																		
19	Reserved.																				
18:16	ClkPinSel. Read-write. Reset: 0. Selects one of clock pin outputs. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>Clock Pins are Disabled</td><td>100b</td><td>CLK[4] is Selected</td></tr><tr><td>001b</td><td>CLK[1] is Selected</td><td>101b</td><td>CLK[5] is Selected</td></tr><tr><td>010b</td><td>CLK[2] is Selected</td><td>110b</td><td>CLK[6] is Selected</td></tr><tr><td>011b</td><td>CLK[3] is Selected</td><td>111b</td><td>CLK[7] is Selected</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	Clock Pins are Disabled	100b	CLK[4] is Selected	001b	CLK[1] is Selected	101b	CLK[5] is Selected	010b	CLK[2] is Selected	110b	CLK[6] is Selected	011b	CLK[3] is Selected	111b	CLK[7] is Selected
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	Clock Pins are Disabled	100b	CLK[4] is Selected																		
001b	CLK[1] is Selected	101b	CLK[5] is Selected																		
010b	CLK[2] is Selected	110b	CLK[6] is Selected																		
011b	CLK[3] is Selected	111b	CLK[7] is Selected																		
15	Reserved.																				

14:8	BusWidthPreset. Read-only. 0=4-bit bus width mode (Data Transfer Width = 1). 1=8-bit bus width mode.			
	<u>Bit</u>	<u>Definition</u>		
	[0]	Bus Width Preset for Device 1		
	[1]	Bus Width Preset for Device 2		
	[2]	Bus Width Preset for Device 3		
	[3]	Bus Width Preset for Device 4		
	[4]	Bus Width Preset for Device 5		
	[5]	Bus Width Preset for Device 6		
	[6]	Bus Width Preset for Device 7		
7:6	Reserved.			
5:4	NumIntInputPins. Read-only. Indicates support of interrupt input pins INT_A#, INT_B# and INT_C# for shared bus system.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Interrupt Input Pin is Not Supported	10b	INTA and INTB are Supported
	01b	INTA is Supported	11b	INTA, INTB and INTC are Supported
3	Reserved.			
2:0	NumofClkPins. Read-only. This field indicates support of clock pins to select one of devices for shared bus system.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	Shared bus is not supported	100b	4 SDCLK pin is supported
	001b	1 SDCLK pin is supported	101b	5 SDCLK pin is supported
	010b	2 SDCLK pin is supported	110b	6 SDCLK pin is supported
	011b	3 SDCLK pin is supported	111b	7 SDCLK pin is supported

SDHC0xFC SDHC_VER_SLOT

Bits	Description
31:24	VendorVersion. Read-only. Reset: 0. Vendor version.
23:16	SpecVersion. Read-only. Reset: 0. Specification version.
15:8	Reserved.
7:0	SlotIntrpt. Read-only. Reset: 0. Interrupt signal for each slot. The value of XSLT_INT7-0 inputs, which indicates the logical OR of Interrupt signal and Wakeup signal, are inverted and referred to by this register. In case of multiple slots, Interrupt signal and Wakeup signal should be logical OR'ed externally and should be inputted to each of XSLT_INT7-0.

3.26.7 SMBus Host Controller

3.26.7.1 Device 14h Function 0 (SMBus) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D14F0x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: Device Identifier. Value: 780Bh. This 16-bit field is assigned by the device manufacturer and identifies the type of device.
15:0	VendorID. Read-only. Reset: 1022h. Vendor Identifier.

D14F0x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; write-1-to-clear. Reset: 0. This bit is set by the device whenever it detects a parity error, even if parity error handling is disabled.
30	SignaledSystemError: Signaled System Error. Read; write-1-to-clear. Reset: 0. This bit is set by the device whenever the device asserts SERR#.
29	ReceivedMasterAbort: Received Master Abort. Read; write-1-to-clear. Reset: 0. This bit is set by a slave device whenever it terminates its transaction with master abort.
28	ReceivedTargetAbort: Received Target Abort. Read; write-1-to-clear. Reset: 0. This bit is set by a master device whenever its transaction is terminated with target abort.
27	SignaledTargetAbort: Signaled Target Abort. Read; write-1-to-clear. Reset: 0. This bit is set by a slave device whenever it terminates a cycle with target abort.
26:25	DEVSELTiming: DEVSEL Timing. Value: 1. These bits encode the timing of DEVSEL#. This module always responds in medium timing.
24	DataParityErrorDetected: Data Parity Error Detected. Read; write-1-to-clear. Reset: 0. 1=The Parity Error Response bit is set and the module has detected PERR# asserted while acting as a PCI master regardless of whether PERR# was driven by this module.
23	FastBack2BackCapable: Fast Back to Back Capable. Value: 0. 0=Fast back to back cycles are not supported.
22	UDFSupported: UDF Supported. Value: 0. 0=User definable feature is not supported.
21	Capable66MHz: 66 MHz Capable. Value: 1. 1=This device is 66 MHz capable.
20	MsiMappingCapability: MSI Mapping Capability. Value: 0. 1=This device supports MSI mapping.
19:10	Reserved. Reset: 1.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Value: 0. ACPI/SMBus does not support fast back-to-back.
8	SERREnable: System Error Enable. Read-write. Reset: 0. 1=Enable system error reporting.
7	WaitCycleControl: Wait Cycle Control. Value: 0. 0=This module does not use address stepping.

6	ParityErrorResponse: Parity Error Response. Read-write. Reset: 0. This bit controls the device's response to parity errors. 1=The device must take its normal action when a parity error is detected. 0=The device must ignore any parity errors that it detects and continue normal operation.
5	VGAPaletteSnoop: VGA Palette Snoop. Value: 0. This bit does not apply to this module.
4	MemoryWriteInvalidateEnable: Memory Write and Invalidate Enable. Value: 0. This module does not generate Memory Write and Invalidate commands.
3	SpecialCycle: Special Cycle. Value: 0. This module does not respond to special cycles.
2	BusMaster: Bus Master. Value: 0. ACPI/SMBus does not have a PCI master.
1	MemorySpace: Memory Space. Read-write. Reset: 1. 1=Enable the device to respond to memory space accesses.
0	IOSpace: IO Space. Read-write. Reset: 1. 1=Enable the device to respond to IO space accesses.

D14F0x08 Revision ID/Class Code

Bits	Description
31:8	ClassCode: Class Code. Value: C0500h. Specifies a SMBus controller.
7:0	RevisionID: Revision ID. Value: 42h.

D14F0x0C Cache Line Size

Bits	Description
31:24	Bist. Value: 0. The module has no built-in-self-test and so this is always 0.
23:16	HeaderType: Header Type. Value: 80h. This device is a multifunction device.
15:8	LatencyTimer: Latency Timer. Value: 0. This register specifies the value of the Latency Timer. This is not used in this module and so it is always 0.
7:0	CacheLineSize: Cache Line Size. Value: 0. Specifies the system cache line size. 0=Device does not use Memory Write and Invalidate commands and CacheLineSize is not applicable.

D14F0x10 Base Address 0

Bits	Description
31:0	BaseAddress0: Base Address 0. Value: 0.

D14F0x14 Base Address 1

Bits	Description
31:0	BaseAddress1: Base Address 1. Value: 0.

D14F0x18 Base Address 2

Bits	Description
31:0	BaseAddress2: Base Address 2. Value: 0.

D14F0x1C Base Address 3

Bits	Description
31:0	BaseAddress3: Base Address 3. Value: 0.

D14F0x20 Base Address 4

Bits	Description
31:0	BaseAddress4: Base Address 4. Value: 0.

D14F0x24 Base Address 5

Bits	Description
31:0	BaseAddress5: Base Address 5. Value: 0.

D14F0x28 Cardbus CIS Pointer

Bits	Description
31:0	CardbusCISPointer: Cardbus CIS Pointer. Value: 0.

D14F0x2C Subsystem Vendor ID

Bits	Description
31:16	SubsystemID: Subsystem ID. Write-once. Reset: 780Bh.
15:0	SubsystemVendorID: Subsystem Vendor ID. Write-once. Reset: 1022h.

D14F0x30 Expansion ROM Base Address

Bits	Description
31:8	Reserved.
7:0	ExpansionROMBaseAddress: Expansion ROM Base Address. Value: 0.

D14F0x34 Capability Pointer

Bits	Description
31:8	Reserved.
7:0	CapabilityPointer: Capability Pointer. Value: 0.

D14F0x3C Interrupt Line

Bits	Description
31:24	MaxLat. Value: 0. Device has no requirements for the setting.
23:16	MinGnt. Value: 0. Device has no requirements for the setting.
15:8	InterruptPin: Interrupt Pin. Value: 0. 0=This module does not generate interrupts.
7:0	InterruptLine: Interrupt Line. Value: 0. 0=This module does not generate interrupts.

3.26.7.2 ASF (Alert Standard Format) Registers

ASF register space is accessed through two methods:

- IO access through ASF IO base address:
 - A. Program the base address of ASF IO space through [PMx00\[SmbusAsfIoBase\]](#).
 - B. Enable ASF IO decoding through [PMx00\[SmbusAsfIoEn\]](#).
- Direct memory mapped access through the AcpiMmio region. The ASF registers range from FED8_0000h+900h to FED8_0000h+9FFh. See [PMx04\[MmioEn\]](#).

ASFx00 HostStatus

Bits	Description
7	LastByte. Read; set-by-hardware; write-1-to-clear. Reset: 0. 0=Last byte has not received. 1=Last byte has received.
6:5	Reserved.
4	PECError. Read; set-by-hardware; write-1-to-clear. Reset: 0. 0=No CRC error. 1=CRC error happened.
3	BusCollision. Read; set-by-hardware; write-1-to-clear. Reset: 0. 0=No bus collision. 1=Bus collision.
2	DevError. Read; set-by-hardware; write-1-to-clear. Reset: 0. 0=Slave device behaves correctly. 1=No ACK or slave device responses incorrectly.
1	Intr. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Termination of a command. Whenever [HostBusy] is cleared, this bit is set.
0	HostBusy. Read-only; updated-by-hardware. Reset: 0. This bit reports the status of the ASF host. 0=SM bus host is idle. 1=SM bus host is busy.

ASFx02 HostControl

Bits	Description
7	PECEnable. Read-write. Reset: 0. 0=PEC disable. 1=PEC enable. Enable CRC checking when ASF HC presents as SM master and SM slave.

6	Start. Write-1-only; Read. Reset: 0. 1=Writing 1 to initiate the command. Always read back as 0.																		
5	PECAppend. Read-write. Reset: 0. 0=No PEC append. 1=Automatic PEC append. ASF HC calculates CRC code and append to the tail of the data packets.																		
4:2	Protocol. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Quick</td></tr> <tr> <td>001b</td><td>Byte</td></tr> <tr> <td>010b</td><td>Byte data</td></tr> <tr> <td>011b</td><td>Word data</td></tr> <tr> <td>100b</td><td>Process call</td></tr> <tr> <td>101b</td><td>Block</td></tr> <tr> <td>110b</td><td>Block write-block read-process call</td></tr> <tr> <td>111b</td><td>Reserved</td></tr> </table>	Bits	Definition	000b	Quick	001b	Byte	010b	Byte data	011b	Word data	100b	Process call	101b	Block	110b	Block write-block read-process call	111b	Reserved
Bits	Definition																		
000b	Quick																		
001b	Byte																		
010b	Byte data																		
011b	Word data																		
100b	Process call																		
101b	Block																		
110b	Block write-block read-process call																		
111b	Reserved																		
1	KillHost. Read-write. Reset: 0. 0=Enable SM master. 1=Reset SM master.																		
0	Reserved.																		

ASFx03 HostCommand

Bits	Description
7:0	HostCommand. Read-write. Reset: 0. Command to be transmitted by master.

ASFx04 SlaveAddress

Bits	Description
7:1	Address. Read-write. Reset: 0. Provide the SM address of slave.
0	RW. Read-write. Reset: 0. 0=Write. 1=Read.

ASFx05 Data0

Bits	Description
7:0	Data0. Read-write. Reset: 0. Contains count or DATA0 field of transaction.

ASFx06 Data1

Bits	Description
7:0	Data1. Read-write. Reset: 0. Contains DATA1 field of transaction.

ASFx07 DataIndex

Bits	Description
7:0	DataIndex. Read-write. Reset: 0. It is mapped to 72 data registers in data buffer for block write/read and block write-block read-process call.

ASFx08 PEC

Bits	Description
7:0	Pec. Read-write. Reset: 0. PEC byte to be sent to slave.

ASFx09 ListenAdr

Bits	Description
7:1	ListenAdr. Read-write. Reset: 0. The slave address which ASF slave responds in listen mode.
0	ListenAdrEn. Read-write. Reset: 0100000b. 1=Enable Listen Mode when the slave address equals to ListenAdr[7:1]. 0=Disable Listen Mode when the slave address equals to ListenAdr[7:1].

ASFx0A ASFStatus

Bits	Description
7:6	SlaveBusy. Read-Only. Reset: 0. Indicates if ASF slave is receiving data.
5	SlaveIntr. Read; write-1-to-clear. Reset: 0. ASF Slave interrupt Status.
4	Reserved.
3	RemotePowerCycle. Read; write-1-to-clear. Reset: 0. 1=Power cycle has been triggered by ASF. 0=No power cycle ASF event.
2	RemotePowerUp. Read; write-1-to-clear. Reset: 0. 1=Power up has been triggered by ASF. 0=No Power up ASF event.
1	RemotePowerDown. Read; write-1-to-clear. Reset: 0. 1=Power down has been triggered by ASF. 0=No Power down ASF event.
0	RemoteReset. Read; write-1-to-clear. Reset: 0. 1=Reset has been triggered by ASF. 0=No Reset cycle ASF event.

ASFx0B StatusMask0

Bits	Description
7:6	Reserved. Reset: 11b.
5	FanSpeed0StatusEnable. Read-write. Reset: 1. 1=Report Fan0 Speed Status to ASF. 0=No report.
4:1	Reserved. Reset: 1111b.
0	Temp0StatusEnable. Read-write. Reset: 1. 1=Report TempTsi status to ASF. 0=No report.

ASFx0C StatusMask1

Bits	Description
7:0	Reserved. Reset: FFh.

ASFx0D SlaveStatus

Bits	Description
7:4	Reserved.
3	WrongSP . Read; write-1-to-clear. Reset: 0. 1=No SP symbol is detected when bus turns to read.
2	SlaveDevError . Read; write-1-to-clear. Reset: 0. 1=Unexpected response.
1	SlaveBusCollision . Read; write-1-to-clear. Reset: 0. 1=BusCollision happens.
0	SlavePECErrror . Read; write-1-to-clear. Reset: 0. 1=PEC error.

ASFx0E RemoteCtrlAdr

Bits	Description
7:1	RemoteCtrlAdr . Read-write. Reset: 54h. SM address of Remote Control device.
0	Reserved.

ASFx0F SensorAdr

Bits	Description
7:1	SensorAdr . Read-write. Reset: 55h. SM address of Sensor.
0	Reserved.

ASFx10 DataReadPointer

Bits	Description
7:0	DataReadPointer . Read-only. Reset: 0. Current read pointer to the value specified in this register.

ASFx11 DataWritePointer

Bits	Description
7:0	DataWritePointer . Read-only. Reset: 0. Show current write pointer to the value specified in this register.

ASFx12 SetDataReadPointer

Bits	Description
7:0	SetDataReadPointer . Read-write. Reset: 0. Force the current write pointer to the value specified in this register.

ASFx13 DataBankSel

Bits	Description										
7	SetReadHostDataBank. Read-write. Reset: 1. 1=Select to read data from Host Data Bank. 0=Select to read data from Data Bank 0 or Data Bank 1 decided by SetReadRevDataBank.										
6	Reserved.										
5:4	SetReadRevDataBank. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Select to read data from Data Bank 0.</td></tr> <tr> <td>01b</td><td>Select to read data from Data Bank 1.</td></tr> <tr> <td>10b</td><td>Select to read data from Data Bank 1.</td></tr> <tr> <td>11b</td><td>Select to read data from Data Bank 1.</td></tr> </table>	Bits	Definition	00b	Select to read data from Data Bank 0.	01b	Select to read data from Data Bank 1.	10b	Select to read data from Data Bank 1.	11b	Select to read data from Data Bank 1.
Bits	Definition										
00b	Select to read data from Data Bank 0.										
01b	Select to read data from Data Bank 1.										
10b	Select to read data from Data Bank 1.										
11b	Select to read data from Data Bank 1.										
3	Databank1Full. Read; write-1-to-clear. Reset: 0. 0=Data Bank 1 is free. 1=Data Bank 1 is full.										
2	Databank0Full. Read; write-1-to-clear. Reset: 0. 0=Data Bank 0 is free. 1=Data Bank 0 is full.										
1	DataBank[1]. Read; write-1-to-clear. Reset: 0. 0=Data Bank still has space. 1=Data Bank is now full.										
0	DataBank[0]. Read; write-1-to-clear. Reset: 1. 0=Data Bank 0 is the latest touched data bank. 1=Data Bank 1 is the latest touched data bank.										

ASFx14 Semaphore

Bits	Description
7:4	Reserved.
3	ClrEcSemaphore. Read; Write-1-only; cleared-by-hardware. Reset: 0. Write 1 to clear [EcSemaphore] bit.
2	EcSemaphore. Read; write-1-only; cleared-by-hardware. Reset: 0. This bit can only be set when [HostSemaphore] is clear.
1	ClrHostSemaphore. Read; Write-1-only; cleared-by-hardware. Reset: 0. Write 1 to clear [HostSemaphore] bit.
0	HostSemaphore. Read; write-1-only; cleared-by-hardware. Reset: 0. Bits [0] and [2] are meant to be used as software semaphore between the host and IMC. When both host and IMC want to use the same resource, they can write to these semaphore bits first, followed by a read. If the read returns a 1 in the semaphore bit, it means it has established the semaphore first. This bit can only be set when EcSemaphore is clear.

ASFx15 SlaveEn

Bits	Description
7	FairArbEn. Read-write. Reset: 0. 0=Disable Fair arbiter logic. 1=Enable Fair Arbiter logic, which forces ASF master to give up SMBus for a certain time, specified in register at offset 16h.
6	TmrOutEn. Read-write. Reset: 1. 1=Enable timer out function.
5	LegacySensorEn. Read-write. Reset: 0. 1=Enable Legacy Sensor.
4	KillSlave. Read-write. Reset: 0. Write 1 to reset Slave ASF Slave state machine.

3	SuspendSlave. Read-write. Reset: 0. Write 1 to Suspend (stop) ASF Slave state machine.
2	Reserved.
1	SlaveIntrListenEn. Read-write. Reset: 0. 1=Allow ASF slave to generate slave interrupt when the address of received packet is the same as the one specified in ListenAdr register ASFx09 [ListenAdr] .
0	Reserved.

ASFx16 DelayMasterTimer

Bits	Description
7:0	FairArbTimer. Read-write. Reset: 04h. Specify how long ASF master has to wait before submitting next packet. Wait time = FairArbTimer* 2 us.

3.26.7.3 SMBus Registers

SMBus register space is accessed through two methods:

- IO access through SMBus IO base address:
 - A. Program the base address of SMBus IO space through [PMx00\[SmbusAsfIoBase\]](#).
 - B. Enable SMBus IO decoding through [PMx00\[SmbusAsfIoEn\]](#).
- Direct memory mapped access through the AcpiMmio region. The SMBus registers range from FED8_0000h+A00h to FED8_0000h+AFFh. See [PMx04\[MmioEn\]](#).

SMBUSx00 SMBusStatus

Bits	Description
7:5	Reserved.
4	Failed. Write-1-to-clear; set-by-hardware; read. Reset: 0. 1=A Failed bus transaction. IF (SMBUSx02[Kill] ==1) THEN SMBUSx00[Failed] =1. ENDIF.
3	BusCollision. Write-1-to-clear; set-by-hardware; read. Reset: 0. 1=An SMBus transaction collision.
2	DeviceErr. Write-1-to-clear; set-by-hardware; read. Reset: 0. 1=An error of one of the following: <ul style="list-style-type: none"> • Illegal command field. • Unclaimed cycle • Host device time-out.
1	SMBusInterrupt. Write-1-to-clear; set-by-hardware; read. Reset: 0. 1=The completion of the last host command.
0	HostBusy. Read-only. Reset: 0. 1=The SMBus controller is in the process of completing a command. When this bit is set, software should not access any other SMBus registers.

SMBUSx01 SMBusSlaveStatus

Bits	Description
7:6	Reserved.
5	AlertStatus. Read-only. Reset: 0.
4	Shadow2Status. Write-1-to-clear; set-by-hardware; read. Reset: 0. This bit is set by hardware to indicate a slave cycle address match of the SMB_Shadow2 port.

3	Shadow1Status. Write-1-to-clear; set-by-hardware; read. Reset: 0. This bit is set by hardware to indicate a slave cycle address match of the SMB_Shadow1 port.
2	SlaveStatus. Write-1-to-clear; set-by-hardware; read. Reset: 0. This bit is set by hardware to indicate a slave cycle event match of the SMBus slave command and SMBus Slave Event match.
1	SlaveInit. RAZ; write-1-only. Reset: 0. Writing a 1 to this bit initializes the slave.
0	SlaveBusy. Read-only. Reset: 0. This bit indicates the SMBus controller slave interface is in the process of receiving data. Software should not try to access any other SMBus register when this bit is set.

SMBUSx02 SMBusControl

Bits	Description																
7	Reset. Write-only. Reset: 0. Set the bit to 1 to stop SMBus transaction and reset SMBus controller state machine.																
6	Start. Read-write. Reset: 0. Writing a 1 in this field initiates SMBus controller host interface to execute the command programmed in the [SMBusProtocol] field.																
5	Reserved.																
4:2	SMBusProtocol. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Quick Read or Write</td></tr> <tr> <td>001b</td><td>Byte Read or Write</td></tr> <tr> <td>010b</td><td>Byte Data Read or Write</td></tr> <tr> <td>011b</td><td>Word Data Read or Write</td></tr> <tr> <td>100b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>Block Read or Write</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	Bits	Definition	000b	Quick Read or Write	001b	Byte Read or Write	010b	Byte Data Read or Write	011b	Word Data Read or Write	100b	Reserved	101b	Block Read or Write	111b-110b	Reserved
Bits	Definition																
000b	Quick Read or Write																
001b	Byte Read or Write																
010b	Byte Data Read or Write																
011b	Word Data Read or Write																
100b	Reserved																
101b	Block Read or Write																
111b-110b	Reserved																
1	Kill. Read-write. Reset: 0. Stop the current host transaction in process.																
0	InterruptEnable. Read-write. Reset: 0. 1=Enable the generation of interrupts on the completion of current host transaction.																

SMBUSx03 SMBusHostCmd

Bits	Description
7:0	SMBusHostCmd. Read-write. Reset: 0. This field contains the data transmitted in the command field of SMBus host transaction.

SMBUSx04 SMBusAddress

Bits	Description
7:1	SMBusAddr. Read-write. Reset: 0. This field contains the 7-bit address of the target slave device.
0	SMBusRdWr. Read-write. Reset: 0. 0=Execute a Write command. 1=Execute a Read command.

SMBUSx05 SMBusData0

Bits	Description
7:0	SMBusData0 . Read-write. Reset: 0. This register should be programmed with a value to be transmitted in the data 0 field of an SMBus host interface transaction. For block write commands, the count of the memory should be stored in this field. The value of this register is loaded into the block transfer count field. A valid value for block command count is between 1 and 32. For block reads, count received from SMBus device is stored here.

SMBUSx06 SMBusData1

Bits	Description
7:0	SMBusData1 . Read-write. Reset: 0. This register should be programmed with a value to be transmitted in the data 1 field of an SMBus host interface transaction. When $(\text{SMBUSx14}[\text{SMBusPoll2Byte}] == 1) \ \& \ ((\text{SMBUSx02}[\text{SMBusProtocol}] == \text{Byte Read/Write}) \mid (\text{SMBUSx02}[\text{SMBusProtocol}] == \text{Byte Data Read/Write}))$, this register is used as the data field in the second transaction.

SMBUSx07 SMBusBlockData

Bits	Description
7:0	SMBusBlockData . Read-write. Reset: 0. This register is used to transfer data into or out of the block data storage array.

SMBUSx08 SMBusSlaveControl

Bits	Description
7	ClrEcSemaphore . Read; Write-1-only; cleared-by-hardware. Reset: 0. Write 1 to clear EcSemaphore bit.
6	EcSemaphore . Read; Write-1-only; cleared-by-hardware. Reset: 0. This bit can only be set when HostSemaphore is clear. Reading returns the value of this bit
5	ClrHostSemaphore . Read; Write-1-only; cleared-by-hardware. Reset: 0. Write 1 to clear HostSemaphore bit.
4	HostSemaphore . Read; Write-1-only; cleared-by-hardware. Reset: 0. Bits 4 and 6 are meant to be used as software semaphore between the host and embedded controller. When both host and IMC want to use the same resource, they can write to these semaphore bits first, followed by a read. If the read returns a 1 in the semaphore bit, it means it has established the semaphore first. Write 1 to set this bit. This bit can only be set when EcSemaphore is clear. Reading returns the value of this bit.
3	SMBusAlertEnable . Read-only. Reset: 0.
2	SMBusShadow2En . Read-write. Reset: 0. Enable the generation of an interrupt or resume event upon an external SMBus master generating a transaction with an address that matches the SMBus Shadow 2 register.

1	SMBusShadow1En. Read-write. Reset: 0. Enable the generation of an interrupt or resume event upon an external SMBus master generating a transaction with an address that matches the SMBus Shadow 1 register.
0	SlaveEnable. Read-write. Reset: 0. Enable the generation of an interrupt or resume event upon an external SMBus master generating a transaction with an address that matches the host controller slave port of 10h, a command field that matches the SMBus slave control register, and a match of corresponding enabled events.

SMBUSx09 SMBusShadowCmd

Bits	Description
7:0	SMBusShadowCmd. Read-write. Reset: 0. This field contains the command value that was received during an external SMBus master access whose address field matched the host slave address (10h) or one of the slave shadow ports.

SMBUSx0A SMBusSlaveEvent

Bits	Description
15:0	SMBusSlaveEvent. Read-write. Reset: 0. This field contains data bits used to compare against incoming data to the SMBus Slave Data register. When a bit in this register is 1 and a corresponding bit in SMBus Slave register is set, then an interrupt or resume event is generated if the command value matches the value in the SMBus slave control register and the access was to SMBus host address 10h.

SMBUSx0C SlaveData

Bits	Description
15:0	SlaveData. Read-write. Reset: 0. This field contains the data value which was transmitted during an external SMBus master access whose address field matched one of the slave shadow port addresses or the SMBus host controller slave port address of 10h.

SMBUSx0E SMBusTiming

Bits	Description
7:0	SMBusTiming. Read-write. Reset: B0h. This register controls the frequency on the SMBus. The formula to calculate the frequency is: $\text{Frequency} = 66 \text{ MHz} / (\text{SMBusTiming} * 4)$.

SMBUSx10 I2CbusConfig

Bits	Description
7:4	I2CRevision. Read-write. Reset: 0. SMBus controller revision.
3:1	Reserved.
0	I2CbusInterrupt. Read-write. Reset: 0. 0=SMI#. 1=IRQ.

SMBUSx11 I2CCommand

Bits	Description
7:0	I2Ccommand . Read-write. Reset: 0. I2C Host Slave Command. This value specifies the command value to be matched for I2C master accesses to the I2Ccontroller host slave interface.

SMBUSx12 I2CShadow1

Bits	Description
7:1	I2CslaveAddr1 . Read-write. Reset: 0. SMBus Slave Address for shadow port 1. This value specifies the address used to match against incoming I2C addresses for Shadow port 1.
0	ReadWriteShadowPort1 . Read-write. Reset: 0. This bit must be programmed to 0 because the I2C slave controller only responds to Word Write Transactions. 0=Write command. 1=Read command.

SMBUSx13 I2Cshadow2

Bits	Description
7:1	I2CslaveAddr2 . Read-write. Reset: 0. SMBus slave address for shadow port 2. This value specifies the address used to match against incoming I2C addresses for Shadow port 2.
0	ReadWriteShadowPort2 . Read-write. Reset: 0. This bit must be programmed to 0 because I2C slave controller only responds to Word Write Transaction. 0=Write command. 1=Read command.

SMBUSx14 SMBusAutoPoll

Bits	Description												
7	SMBusPoll2Byte . Read-write. Reset: 1. 1=IF ((SMBUSx02 [SMBusProtocol]==Byte Read/Write) (SMBUSx02 [SMBusProtocol]==Byte Data Read/Write)) THEN the last command will be performed twice at each polling interval. SMBUSx06 [SMBusData1] contains data transmitted and retrieved from the second transaction. SMBUSx17 [SMBusHostCmd2]contains data transmitted in the command field in the second transaction.												
6:4	Reserved.												
3:1	SMBusPollPeriod . Read-write. Reset: 2h. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>poll every 1/16 second</td></tr> <tr> <td>001b</td><td>poll every 1/8 second</td></tr> <tr> <td>010b</td><td>poll every 1/4 second</td></tr> <tr> <td>011b</td><td>poll every 1/2 second</td></tr> <tr> <td>111b-100b</td><td>poll every 1 second</td></tr> </table>	Bits	Definition	000b	poll every 1/16 second	001b	poll every 1/8 second	010b	poll every 1/4 second	011b	poll every 1/2 second	111b-100b	poll every 1 second
Bits	Definition												
000b	poll every 1/16 second												
001b	poll every 1/8 second												
010b	poll every 1/4 second												
011b	poll every 1/2 second												
111b-100b	poll every 1 second												
0	SMBusAutoPollEn . Read-write. Reset: 0. 1=SMBus will periodically execute the last command whenever SMBUSx15 [SMBusCounter] expires. The polling interval is defined by [SMBusPollPeriod]. The purpose of this function is to use the SMBus to read CPU temperature via TSI. Values in SMBUSx05 [SMBusData0] and SMBUSx06 [SMBusData1] are to be used for controlling the fan speed.												

SMBUSx15 SMBusCounter

Bits	Description
7:0	SMBusCounter . Read-only; updated-by-hardware. This counter specifies the remaining time until the next read specified as (SMBusCounter*SMBUSx14[SMBusPollPeriod]/256) us.

SMBUSx16 SMBusStop

Bits	Description
15:1	Reserved.
0	SMBusPausePoll . Read-write. Reset: 0. This is to be used as a semaphore mechanism by software to stop the next polling. If software wants to use the SMBus for other purposes but the hardware has already been enabled (SMBUSx14[SMBusAutoPollEn]=1) to perform auto polling, software can halt the next polling by setting this bit to 1. If the halt is successful, this bit will return 1. If the HW has already started the polling operation at the same time software tries to set this bit, this bit will return 0. When the pending polling operation is finally complete, this bit will then get set. When this bit is set, polling counter will temporarily stop (not reset). It is now safe for software to access the SMBus. Upon completion, software must restore the previous command in the appropriate register prior to setting this bit. software should also clear this bit so the counter can resume counting.

SMBUSx17 SMBusHostCmd2

Bits	Description
7:0	SMBusHostCmd2 . Read-write. Reset: 0. This field contains the data transmitted in the command field in the second command when (SMBUSx14[SMBusPoll2Byte]==1) and (SMBUSx02[SMBus-Protocol]==Byte Data Read/Write).

3.26.8 IOAPIC Registers

IOAPIC configuration registers can be accessed at memory region from FEC0_0000h to FEC0_007Fh. Program [PMx00\[IoApicEn\]=1](#) to enable IOAPIC decoding.

IOAPICx00 IO Register Select Register

Bits	Description
31:8	Reserved.
7:0	IndirectAddressOffset . Read-write. Reset: 0. Indirect Address Offset to IO Window Register. It is used to determine which register is manipulated during an IO Window Register read/write operation.

IOAPICx10 IO Window Register

Bits	Description
31:0	IOWindow . Read-write. Reset: 0. Mapped by IOAPICx00 to the designated indirect access register.

IOAPICx10_x00 IOAPIC ID Register

This register is not used in IOxAPIC PCI bus delivery mode.

Bits	Description
31:28	Reserved.
27:24	ID . Read-write. Reset: 0. IOAPIC device ID.
23:0	Reserved.

IOAPICx10_x01 IOAPIC Version Register

Bits	Description
31:24	Reserved.
23:16	MaxRedirectionEntries . Value: 17h. Indicates 24 entries [23:0].
15	PRQ . Value: 1. IRQ pin assertion supported.
14:8	Reserved.
7:0	Version . Value: 21h. PCI 2.2 compliant.

IOAPICx10_x02 IOAPIC Arbitration Register

This register is not used in IOxAPIC PCI bus delivery mode.

Bits	Description
31:28	Reserved.
27:24	ArbitrationID: Arbitration ID . Read-only. Reset: 0.
23:0	Reserved.

IOAPICx10_x[3E:10:step2] Redirection Table Entry [23:0]

Bits	Description																				
63:56	DestinationID. Read-write. Reset: 0. Bits [19:12] of the address field of the interrupt message.																				
55:32	Reserved.																				
31:17	Reserved.																				
16	Mask. Read-write. Reset: 1. 1=Mask the interrupt injection at the input of this device. 0=Unmask.																				
15	TriggerMode. Read-write. Reset: 0. 0=Edge. 1=Level.																				
14	RemoteIRR. Read-only. Reset: 0. Used for level triggered interrupts only. It is cleared by EOI special cycle transaction or write to EOI register. 1=Interrupt message is delivered.																				
13	InterruptPinPolarity. Read-write. Reset: 0. 0=High. 1=Low.																				
12	DeliveryStatus. Read-only. Reset: 0. 0=Idle. 1=Send Pending.																				
11	DestinationMode. Read-write. Reset: 0. 0=Physical. 1=Logical.																				
10:8	DeliveryMode. Read-write. Reset: 0. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>Fixed</td><td>100b</td><td>NMI</td></tr><tr><td>001b</td><td>Lowest Priority</td><td>101b</td><td>INIT</td></tr><tr><td>010b</td><td>SMI/PMI</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>Reserved</td><td>111b</td><td>ExtINT</td></tr></table>	Bits	Definition	Bits	Definition	000b	Fixed	100b	NMI	001b	Lowest Priority	101b	INIT	010b	SMI/PMI	110b	Reserved	011b	Reserved	111b	ExtINT
Bits	Definition	Bits	Definition																		
000b	Fixed	100b	NMI																		
001b	Lowest Priority	101b	INIT																		
010b	SMI/PMI	110b	Reserved																		
011b	Reserved	111b	ExtINT																		
7:0	Vector. Read-write. Reset: 0. Interrupt vector associated with this interrupt input.																				

IOAPICx20 IRQ Pin Assertion Register

Bits	Description
31:8	Reserved.
7:0	InputIrq. Read-write. Reset: 0. IRQ number for the requested interrupt. A write to this register will trigger an interrupt associated with the redirection table entry referenced by the IRQ number. Currently the redirection table has 24 entries. Writes with IRQ number greater than 17h have no effect.

IOAPICx40 EOI Register

Bits	Description
31:8	Reserved.
7:0	Vector. Write-only. Reset: 0. Interrupt vector. A write to this register will clear the remote IRR bit in the redirection table entry found matching the interrupt vector. This provides an alternate mechanism other than PCI special cycle for EOI to reach IOxAPIC.

3.26.9 LPC-ISA Bridge

3.26.9.1 Device 14h Function 3 (LPC Bridge) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

D14F3x00 Device/Vendor ID

Bits	Description
31:16	DeviceID: Device Identifier. Value: 780Eh. This 16-bit field is assigned by the device manufacturer and identifies the type of device.
15:0	VendorID: Vendor Identifier. Read-only. Reset: 1022h.

D14F3x04 Status/Command

Bits	Description
31	DetectedParityError: Detected Parity Error. Read; write-1-to-clear. Reset: 0. 1=The FCH detects a parity error.
30	SignaledSystemError: Signaled System Error. Read; write-1-to-clear. Reset: 0. 1=The FCH detects a PCI address parity error.
29	ReceivedMasterAbort: Received Master Abort. Read; write-1-to-clear. Reset: 0. 1=The FCH acts as a PCI master and aborts a PCI bus memory cycle.
28	ReceivedTargetAbort: Received Target Abort. Read; write-1-to-clear. Reset: 0. 1=An FCH generated PCI cycle (the FCH is the PCI master) is aborted by a PCI target.
27	SignaledTargetAbort: Signaled Target Abort. Read; write-1-to-clear. Reset: 0. 1=The FCH signals target abort.
26:25	DeviceSelectTiming: Device Select Timing. Value: 1. Indicates DEVSEL# timing when performing a positive decode. DEVSEL# is asserted to meet the medium timing.
24	MasterDataParityError: Master Data Parity Error. Read; write-1-to-clear. Reset: 0. 1=The FCH detects PERR# asserted while acting as PCI master regardless whether PERR# was driven by the FCH or not.
23:21	Reserved.
20	CapabilitiesList: Capabilities List. Read-only. Reset:0.
19:10	Reserved.
9	FastBack2BackEnable: Fast Back-to-Back Enable. Value: 0.
8	SERREnable: SERR# Enable. Read-only. Reset: 0. 1=The FCH asserts SERR# when it detects an address parity error. 0=SERR# is not asserted.
7	SteppingControl: Stepping Control. Value: 0.
6	ParityErrorResponse: Parity Error Response. Read-write. Reset: 0. PERR# (Response) Detection Enable bit. 1=The FCH asserts PERR# when it is the agent receiving data and it detects a parity error. 0=PERR# is not asserted.
5	VGAPaletteSnoop: VGA Palette Snoop. Value: 0.

4	MemoryWriteAndInvalidateEnable: Memory Write and Invalidate Enable. Value: 0.
3	SpecialCycles: Special Cycles. Value: 1.
2	BusMaster: Bus Master. Read-only. Reset: 1. 1=Bus master enabled.
1	MemorySpace: Memory Space. Value: 1.
0	IOspace: IO Space. Read-only. Reset: 1. This bit controls access to the IO space registers. 1=Enable access to the legacy IDE ports, and PCI bus master IDE IO registers are enabled.

D14F3x08 Revision ID/Class Code

Bits	Description
31:8	ClassCode: Class Code. Read-only. Reset: 60100h. Indicates an ISA bridge.
7:0	RevisionID: Revision ID. Value: 11h. Indicates the revision level of the chip design.

D14F3x0C Cache Line Size

Bits	Description
31:24	Bist. Read-only. Reset: 0. No BIST modes.
23:16	HeaderType: Header Type. Read-only. Reset: 80h. Identifies the type of the predefined header in the configuration space. The most significant bit is set to 1 to indicate a multifunction device.
15:8	LatencyTimer: Latency Timer. Read-only. Reset: 0. Specifies the value of the latency timer in units of PCICLKs.
7:0	CacheLineSize: Cache Line Size. Value: 0.

D14F3x10 Base Address Reg 0

Bits	Description
31:5	BaseAddress0[31:5]: Base Address 0. RAZ; write-only. Reset: 7F60000h. This register has an internal value used as base address for APIC memory space. Writing to the register changes its internal value. The default internal base address is FEC0_0000h.
4:0	BaseAddress0[4:0]. Value: 0.

D14F3x2C Subsystem ID and Subsystem Vendor ID

Bits	Description
31:16	SubsystemID: Subsystem ID. Write-once; Read. Reset: 780Eh.
15:0	SubsystemVendorID: Subsystem Vendor ID. Write-once; Read. Reset: 1022h.

D14F3x34 Capabilities Pointer

Bits	Description
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31:8	Reserved.
7:0	CapabilitiesPointer: Capabilities Pointer. Read-only. Reset:0.

D14F3x40 PCI Control

Bits	Description
31:8	Reserved.
7	IntegratedEcPresent. Read-Only; Updated by hardware. Reset: 0. 1=IMC is present.
6	EcSemaphore. Read-write. Reset: 0. This bit is writable by IMC and read by BIOS. This is used as the software semaphore mechanism between BIOS and IMC to see who can access the common resource. IMC should read bit [BiosSemaphore] first to see if BIOS has taken ownership of the resource. If [BiosSemaphore] == 0, then IMC should write a 1 to this bit and then follow by a read to see if this bit is set. If this bit is set, it means IMC has successfully taken ownership of the resource. If this bit returns a 0 and [BiosSemaphore] returns a 1, then BIOS has taken ownership first. IMC should always clear this bit after it has completed its access to the resource.
5	BiosSemaphore. Read-write. Reset: 0. This bit is writable by BIOS and read by the IMC. This is used as the software semaphore mechanism between BIOS and IMC to see who can access the common resource. BIOS should read bit [EcSemaphore] first to see if IMC has taken ownership of the resource. If [EcSemaphore] == 0, then BIOS should write a 1 to this bit and then follow by a read to see if this bit is set. If this bit is set, it means BIOS has successfully taken ownership of the resource. If this bit returns 0 and [EcSemaphore] returns a 1, then IMC has taken ownership first. Software should always clear this bit after it has completed its access to the resource.
4:3	Reserved.
2	LegacyDmaEnable: Legacy DMA Enable. Read-write. Reset: 1. BIOS: See 2.17.4.1. 1=Enable LPC DMA cycle. Transfer size for channel 3-0 is 8 bits; Transfer size for channel 7-5 is 16 bits. 32-bit DMA is not supported.
1:0	Reserved.

D14F3x44 IO Port Decode Enable

Bits	Description
31	AdLibPortEnable: Ad-Lib Port Enable. Read-write. Reset: 0. Port enable for Ad-Lib port, 388h-389h. 1=Enable the IO range.
30	AcpiMicroControllerPortEnable: ACPI Micro-Controller Port Enable. Read-write. Reset: 0. Port enable for ACPI micro-controller port, 62h & 66h. 1=Enable the IO range.
29	KBCPortEnable: KBC Port Enable. Read-write. Reset: 0. Port enable for KBC port, 60h & 64h. 1=Enable the IO range.
28	GamePortEnable: Game Port Enable. Read-write. Reset: 0. Port enable for game port, 200h-20Fh. 1=Enable the IO range.
27	FDCPortEnable1: FDC Port Enable 1. Read-write. Reset: 0. Port enable for FDC port, 370h-377h. 1=Enable the IO range.
26	FDCPortEnable0: FDC Port Enable 0. Read-write. Reset: 0. Port enable for FDC port, 3F0h-3F7h. 1=Enable the IO range.

25	MSSPortEnable3: MSS Port Enable 3. Read-write. Reset: 0. Port enable for MSS port, F40h-F47h. 1=Enable the IO range.
24	MSSPortEnable2: MSS Port Enable 2. Read-write. Reset: 0. Port enable for MSS port, E80h-E87h. 1=Enable the IO range.
23	MSSPortEnable1: MSS Port Enable 1. Read-write. Reset: 0. Port enable for MSS port, 604h-60bh. 1=Enable the IO range.
22	MSSPortEnable0: MSS Port Enable 0. Read-write. Reset: 0. Port enable for MSS port, 530h-537h. 1=Enable the IO range.
21	MIDIPortEnable3: MIDI Port Enable 3. Read-write. Reset: 0. Port enable for MIDI port, 330h-331h. 1=Enable the IO range.
20	MIDIPortEnable2: MIDI Port Enable 2. Read-write. Reset: 0. Port enable for MIDI port, 320h-321h. 1=Enable the IO range.
19	MIDIPortEnable1: MIDI Port Enable 1. Read-write. Reset: 0. Port enable for MIDI port, 310h-311h. 1=Enable the IO range.
18	MIDIPortEnable0: MIDI Port Enable 0. Read-write. Reset: 0. Port enable for MIDI port, 300h-301h. 1=Enable the IO range.
17	AudioPortEnable3: Audio Port Enable 3. Read-write. Reset: 0. Port enable for audio port, 280h-293h. 1=Enable the IO range.
16	AudioPortEnable2: Audio Port Enable 2. Read-write. Reset: 0. Port enable for audio port, 260h-273h. 1=Enable the IO range.
15	AudioPortEnable1: Audio Port Enable 1. Read-write. Reset: 0. Port enable for audio port, 240h-253h. 1=Enable the IO range.
14	AudioPortEnable0: Audio Port Enable 0. Read-write. Reset: 0. Port enable for audio port, 230h-233h. 1=Enable the IO range.
13	SerialPortEnable7: Serial Port Enable 7. Read-write. Reset: 0. Port enable for serial port, 3E8h-3EFh. 1=Enable the IO range.
12	SerialPortEnable6: Serial Port Enable 6. Read-write. Reset: 0. Port enable for serial port, 338h-33Fh. 1=Enable the IO range.
11	SerialPortEnable5: Serial Port Enable 5. Read-write. Reset: 0. Port enable for serial port, 2E8h-2EFh. 1=Enable the IO range.
10	SerialPortEnable4: Serial Port Enable 4. Read-write. Reset: 0. Port enable for serial port, 238h-23Fh. 1=Enable the IO range.
9	SerialPortEnable3: Serial Port Enable 3. Read-write. Reset: 0. Port enable for serial port, 228h-22Fh. 1=Enable the IO range.
8	SerialPortEnable2: Serial Port Enable 2. Read-write. Reset: 0. Port enable for serial port, 220h-227h. 1=Enable the IO range.
7	SerialPortEnable1: Serial Port Enable 1. Read-write. Reset: 0. Port enable for serial port, 2F8h-2FFh. 1=Enable the IO range.
6	SerialPortEnable0: Serial Port Enable 0. Read-write. Reset: 0. Port enable for serial port, 3F8h-3FFh. 1=Enable the IO range.
5	ParallelPortEnable5: Parallel Port Enable 5. Read-write. Reset: 0. Port enable for parallel port, 7BCh-7BFh. 1=Enable the IO range.
4	ParallelPortEnable4: Parallel Port Enable 4. Read-write. Reset: 0. Port enable for parallel port, 3BCh-3BFh. 1=Enable the IO range.

3	ParallelPortEnable3: Parallel Port Enable 3. Read-write. Reset: 0. Port enable for parallel port, 678h-67Fh. 1=Enable the IO range.
2	ParallelPortEnable2: Parallel Port Enable 2. Read-write. Reset: 0. Port enable for parallel port, 278h-27Fh. 1=Enable the IO range.
1	ParallelPortEnable1: Parallel Port Enable 1. Read-write. Reset: 0. Port enable for parallel port, 778h-77Fh. 1=Enable the IO range.
0	ParallelPortEnable0: Parallel Port Enable 0. Read-write. Reset: 0. Port enable for parallel port, 378h-37Fh. 1=Enable the IO range.

D14F3x48 IO/Mem Port Decode Enable

Bits	Description
31:26	Reserved.
25	WideIO2Enable. Read-write. Reset: 0. Port enable for wide generic IO port 2 defined by D14F3x90 [IOBaseAddress2]. 1=Enable the IO range.
24	WideIO1Enable. Read-write. Reset: 0. Port enable for wide generic IO port 1 defined by D14F3x64 [IOBaseAddress1]. 1=Enable the IO range.
23	IOPortEnable6: IO port enable 6. Read-write. Reset: 0. Port enable for IO port FD60h-FD6Fh. 1=Enable the IO range.
22	IOPortEnable5: IO port enable 5. Read-write. Reset: 0. Port enable for IO port 4700h-470Bh. 1=Enable the IO range.
21	IOPortEnable4: IO port enable 4. Read-write. Reset: 1. Port enable for IO port 80h. 1=Enable the IO range.
20	MemPortEnable: Mem port enable. Read-write. Reset: 0. Port enable for 4K byte memory range defined in D14F3x4C [Memory Range]. 1=Enable the memory range.
19	IOPortEnable3: IO port enable 3. Read-write. Reset: 0. Port enable for IO port 580h-5BFh. 1=Enable the IO range.
18	IOPortEnable2: IO port enable 2. Read-write. Reset: 0. Port enable for IO port 500h-53Fh. 1=Enable the IO range.
17	IOPortEnable1: IO port enable 1. Read-write. Reset: 0. Port enable for IO port 480h-4BFh. 1=Enable the IO range.
16	IOPortEnable0: IO port enable 0. Read-write. Reset: 0. Port enable for IO port 400h-43Fh. 1=Enable the IO range.
15:8	SyncTimeoutCount: Sync Timeout Count. Read-write. Reset: FFh. When [SyncTimeoutCounterEnable] == 1, this is the number of LPC clocks that the state machine will wait during LPC data sync before aborting the cycle.
7	SyncTimeoutCounterEnable: Sync Timeout Counter Enable. Read-write. Reset: 0. 1=LPC sync timeout counter is enabled. 0=The counter is disabled. This counter is used to avoid a deadlock condition if an LPC device drives sync forever. Timeout count is programmed in [SyncTimeoutCount]. Write 0 to this bit if an LPC device is extremely slow and takes more than 255 LPC clocks to complete a cycle.
6	RtcIORangePortEnable: RTC IO Range Port Enable. Read-write. Reset: 0. Port enable for RTC IO range 70h-73h. 1=Enable the IO range.

5	MemoryRangePortEnable: Memory Range Port Enable. Read-write. Reset: 0. Port enable for LPC memory target range defined by D14F3x60 [PCI Memory Address for LPC Target Cycles] . 1=Enable the memory range.
4	Reserved.
3	Reserved.
2	WideIO0Enable. Read-write. Reset: 0. Port enable for wide generic IO port defined by D14F3x64[IOBaseAddress0] . 1=Enable the IO range.
1	AlternateSuperIOConfigurationPortEnable: Alternate Super IO Configuration Port Enable. Read-write. Reset: 0. Port enable for alternate Super IO configuration port, 4Eh-4Fh. 1=Enable the IO range.
0	SuperIOConfigurationPortEnable: Super IO Configuration Port Enable. Read-write. Reset: 0. Port enable for Super IO configuration port, 2Eh-2Fh. 1=Enable the IO range.

D14F3x4C Memory Range

Bits	Description
31:12	BaseAddress: Base Address. Read-write. Reset: 0. Specifies a 4K byte memory range from {Base Address, 000h} to {Base Address, FFFh}. The range is enabled by D14F3x48[MemPortEnable] .
11:0	Reserved.

D14F3x[5C,58,54,50] ROM Protect 3, 2, 1, 0

These registers specify different ROM ranges to be protected. [SPIx1D\[SpiProtectEn0\]](#) enables the protection ranges. The addresses are within the defined ROM range if:

{RomBase, 000_0000_0000b} <= address[31:0] <= ({RomBase, 000_0000_0000b} + (Range << (RangeUnit ? 16 : 12))).

For host, these registers can only be written once after hardware reset; Subsequent writes to it have no effect. For IMC, these registers are always read-writable.

Bits	Description
31:11	RomBase: ROM Base. Read; write-once. Reset: 0.
10	WriteProtect: Write Protect. Read; write-once. Reset: 0. 1=The memory range defined by this register is write-protected and writing to the range has no effect.
9	ReadProtect: Read Protect. Read; write-once. Reset: 0. 1=The memory range defined by this register is read-protected and reading any location in the range returns FFFF_FFFFh.
8	RangeUnit. Read; write-once. Reset: 0. 0=4 KB. 1=64 KB.
7:0	Range. Read; write-once. Reset: 0. Specifies the protected range. The unit is defined by RangeUnit.

D14F3x60 PCI Memory Address for LPC Target Cycles

This register contains the upper 16 bits of the start and end address of the LPC memory target range. The lower 16 bits of MemoryStartAddress are 0000h. The lower 16 bits of MemoryEndAddress are FFFFh. This range can be enabled or disabled using [D14F3x48\[MemoryRangePortEnable\]](#).

Bits	Description
31:16	MemoryEndAddress: Memory End Address. Read-write. Reset: 0. Specifies the upper 16 bits of the end address of the LPC target memory range.
15:0	MemoryStartAddress: Memory Start Address. Read-write. Reset: 0. Specifies the upper 16 bits of the start address of the LPC target memory range.

D14F3x64 PCI IO base Address for Wide Generic Port

Bits	Description
31:16	IOBaseAddress1: IO Base Address 1. Read-write. Reset: 0. 16-bit PCI IO base address for wide generic IO port range. This function is enabled by D14F3x48 [WideIO1Enable]. If D14F3x74 [AlternativeWideIO1RangeEnable] == 1, the range is 16 bytes; else the range is 512 bytes.
15:0	IOBaseAddress0: IO Base Address 0. Read-write. Reset: 0. 16-bit PCI IO base address for wide generic IO port range. This function is enabled by D14F3x48 [WideIO0Enable]. If D14F3x74 [AlternativeWideIO0RangeEnable] == 1, the range is 16 bytes; else the range is 512 bytes.

D14F3x68 ROM Address Range 1

This register contains the upper 16 bits of the start and end address of the ROM address range 1. The lower 16 bits of RomStartAddress1 are 0000h. The lower 16 bits of the RomEndAddress1 are FFFFh. This range can be enabled or disabled using [D14F3x48](#)[RomRange1PortEnable]. This register is used for both LPC and SPI flash.

Bits	Description
31:16	RomEndAddress1: ROM End Address 1. Read-write. Reset: 0Fh. Specifies the upper 16 bits of the end address of the ROM memory address range 1.
15:0	RomStartAddress1: ROM Start Address 1. Read-write. Reset: 08h. Specifies the upper 16 bits of the start address of the ROM memory address range 1.

D14F3x6C ROM Address Range 2

This register contains the upper 16 bits of the start and end address of the ROM address range 2. The lower 16 bits of RomStartAddress2 are 0000h. The lower 16 bits of RomEndAddress2 are FFFFh. This range can be enabled or disabled using [D14F3x48](#)[RomRange2PortEnable]. This register is used for both LPC and SPI flash.

Bits	Description
31:16	RomEndAddress2: ROM End Address 2. Read-write. Reset: FFFFh. Specifies the upper 16 bits of the end address of the ROM memory address range 2.
15:0	RomStartAddress2: ROM Start Address 2. Read-write. Reset: FFF8h. Specifies the upper 16 bits of the start address of the ROM memory address range 2.

D14F3x74 Alternative Wide IO Range Enable

Bits	Description
31:4	Reserved.
3	AlternativeWideIO2RangeEnable: Alternative Wide IO 2 Range Enable. Read-write. Reset: 0. This bit is similar to bit [AlternativeWideIO0RangeEnable], but it applies to the IO range defined by D14F3x90 [IOBaseAddress2]. See bit[AlternativeWideIO0RangeEnable] for detailed description.
2	AlternativeWideIO1RangeEnable: Alternative Wide IO 1 Range Enable. Read-write. Reset: 0. This bit is similar to bit [AlternativeWideIO0RangeEnable], but it applies to the IO range defined by D14F3x64 [IOBaseAddress1]. See bit [AlternativeWideIO0RangeEnable] for detailed description.
1	Reserved.
0	AlternativeWideIO0RangeEnable: Alternative Wide IO 0 Range Enable. Read-write. Reset: 0. 0=Wide IO range defined by D14F3x64 [IOBaseAddress0] is 512 bytes. 1=The range is 16 bytes. To use this feature, address in D14F3x64 [IOBaseAddress0] must be aligned to 16 bytes, i.e., bits[3:0] must be 0. If the address is not aligned to 16 bytes, the IO range is from address[15:0] to {address[15:4], 0xF}.

D14F3x78 Miscellaneous Control Bits

Bits	Description
31:11	Reserved.
10	Reserved.
9	Reserved.
8	Reserved.
7	AllowHostInDma. Read-write. Reset: 1. 1=Allow Host to access LPC if ACPI has not given GNT to LPC during DMA transfer. 0=DMA hold LPC even ACPI has not given GNT to LPC during DMA transfer.
6	GateWrongRx. Read-write. Reset: 0. 1=Allow AltRxByteCount to be 0.
5	GateSpiAccessDis. Read-write. Reset: 0. 1=Pass ROM access to SPI even if it is strapped as LPC.
4	SMMWriteRomEn. Read-write. Reset: 1. 1=Enable ROM access in SMM mode.
3	LDRQ1. Read-write. Reset: 0. BIOS: See 2.17.4.1 . 1=Enable LDRQ1# on LPC bus.
2	LDRQ0. Read-write. Reset: 0. BIOS: See 2.17.4.1 . 1=Enable LDRQ0# on LPC bus.
1	Reserved.
0	NoHog: No Hog. Read-write. Reset: 1. BIOS: See 2.17.4.1 . 1=The internal bus is not locked by LPC bridge during a slave access (eg. LPC DMA fetch). 0=LPC may hold the internal bus during a DMA transfer.

D14F3x7C TPM

Bits	Description
31:14	Reserved.
13	TpmBufferEn. Read-write. Reset: 0. 1=Enable TPM buffer. 0=Disable TPM buffer.

12	TpmPfetchEn. Read-write. Reset: 0. 1=Enable TPM burst read. 0=Disable TPM burst read.										
11	LpcClk1IsGpio. Read-write. Reset: 1. 1=Treat LpcClk1 as GPIO. 0=Treat LpcClk1 as LpcClk1.										
10	GpioLpcClk1Out. Read-write. Reset: 0. Control GpioLpcClk1 output value.										
9	GpioLpcClk1OeB. Read-write. Reset: 1. 1=disable GpioLpcClk1 output. 0=Enable GpioLpcClk1 output.										
8	GpioLpcClk1. Read-only. Reset: X. Status of LpcClk1 port.										
7	WiderTpmEn. Read-write. Reset: 0. 1=Force logic to decode FED4_XXXXh as TPM cycles instead of FED4_0XXXXh, FED4_1XXXXh, FED4_2XXXXh, FED4_3XXXXh, and FED4_4XXXXh.										
6:5	TmkbcSel. Read-write. Reset: 0. Select which one of the four sets of TMKBC registers specified in D14F3x84 , D14F3x88 , D14F3x8C are accessed. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>set 0</td></tr> <tr> <td>01b</td><td>set 1</td></tr> <tr> <td>10b</td><td>set 2</td></tr> <tr> <td>11b</td><td>set 3</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	set 0	01b	set 1	10b	set 2	11b	set 3
<u>Bits</u>	<u>Definition</u>										
00b	set 0										
01b	set 1										
10b	set 2										
11b	set 3										
4	TmkbcSet. Write-once. Reset: 0. 1=All TMKBC address/remap registers cannot be changed until the next reset.										
3	TmkbcEnable. Read-write. Reset: 0. 1=Enable the TMKBC function.										
2	TpmLegacy. Read-write. Reset: 0. 1=Enable decoding of legacy TPM addresses: IO addresses 7Eh/7Fh and EEh/EFh.										
1	Reserved.										
0	Tpm12En. Read-write. Reset: 0. 1=Enable decoding of TPM cycles defined in TPM1.2 spec. Note that this bit and [TpmLegacy] are independent bits; they respectively turn on decoding of different TPM addresses.										

D14F3x84 TMKBC_BaseAddrLow

Bits	Description
31:7	TmkbcBaseAddrLow. Read-write. Reset: 0. This register defines the lower 32 bit memory address used for the TMKBC function. There are actually four sets of such mapping. The selection is controlled by D14F3x7C [TmkbcSel].
6	MaskBits13thru8. Read-write. Reset: 0. Defines whether TMKBC address bits [13:8] are masked as do-not-care bits. 1=Masked. 0=No mask.
5	MaskBits12thru8. Read-write. Reset: 0. Defines whether TMKBC address bits [12:8] are masked as do-not-care bits. 1=Masked. 0=No mask.
4	MaskBits11thru8. Read-write. Reset: 0. Defines whether TMKBC address bits [11:8] are masked as do-not-care bits. 1=Masked. 0=No mask.
3	MaskBits10thru8. Read-write. Reset: 0. Defines whether TMKBC address bits[10:8] are masked as do-not-care bits. 1=Masked. 0=No mask.
2	Addr64. Read-write. Reset: 0. Defines whether the TMKBC address is 32 or 64 bits. 1=The address is 64-bit. 0=The address is 32-bit.
1:0	Reserved.

D14F3x88 TMKBC_BaseAddrHigh

Bits	Description
31:0	TmkbcBaseAddrHigh . Read-write. Reset: 0. If D14F3x84 [Addr64] == 1, this register defines the upper 32 bit memory address used for the TMKBC function. If D14F3x84 [Addr64] == 0, this register has no meaning. There are four sets of such mapping. The selection is controlled by D14F3x7C [TmkbcSel].

D14F3x8C TMKBC_Remap

Bits	Description
31:16	Reserved.
15:8	TmkbcRemap . Read-write. Reset: 0. This register defines the remap address [15:8] on the LPC bus. There are four sets of such mapping. The selection is controlled by D14F3x7C [TmkbcSel].
7:0	Reserved.

D14F3x90 Wide IO 2

Bits	Description
31:16	Reserved.
15:0	IOBaseAddress2: IO Base Address 2 . Read-write. Reset: 0. 16-bit PCI IO base address for wide generic IO port range. This function is enabled by D14F3x48 [WideIO2Enable]. If D14F3x74 [AlternativeWideIO2RangeEnable] == 1, the range is 16 bytes; else, the ranges is 512 bytes.

D14F3x98 EC_LPC_Cntrl

Bits	Description
31:9	Reserved.
8	EcHoldLpc . Read-write. Reset: 0. 1=IMC holds the LPC bridge and host cannot access LPC.
7	Reserved.
6:1	Reserved.
0	HostHoldLpc . Read-write. Reset: 0. 1=Host holds the LPC bridge and prevents IMC from accessing LPC.

D14F3xA0 SPI Base_Addr

Bits	Description
31:6	SpiBaseAddr [31:6]. Read-write. Reset: 0. BIOS: See 2.17.4 . This register specifies the MMIO base address for the SPI ROM controller registers. See 3.26.9.2 [SPI Registers] .
5:4	Reserved.

3	RouteTpm2Spi. Read-write. Reset: 0. 1=TPM cycles are routed to SPI bus with TPM_SPI_CS# asserted.
2	Reserved.
1	SpiRomEnable. Read-write. Reset: 1. 1=SPI ROM is enabled if chip is strapped to SPI ROM. 0=SPI ROM is disabled.
0	Reserved.

D14F3xA4 EC_PortAddress

Bits	Description
31:16	Reserved.
15:1	EcPortAddr15_1. IF (D14F3xB8[EcPortHostAccessEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 17h. If this field is non-zero, [EcPortActive] is set to 1, and an IO cycle from host has address[15:1] == EcPortAddr15_1, the cycle is routed to IMC.
0	EcPortActive. Read-write. Reset: 1. 1=LPC can decode the address specified in [EcPortAddr15_1]. 0= LPC ignores it.

D14F3xB0 RomDmaSrcAddr

Bits	Description
31:6	DmaStartAddr. Read-write. Reset: 0. Specifies the starting DMA address to read from the ROM. Note this is not the same as the legacy DMA function. This is meant to be used by BIOS to fetch BOOT code quicker.
5:0	Reserved.

D14F3xB4 RomDmaDstAddr

Bits	Description
31:6	DmaDstAddr. Read-write. Reset: 0. Specifies the target DMA address to be written in the system memory. Note this is not the same as the legacy DMA function. This is meant to be used by BIOS to fetch BOOT code quicker.
5:0	Reserved.

D14F3xB8 RomDmaControl/EcControl/HostControl

Bits	Description
31:30	Reserved.
29	PrefetchMissEnHost. Read-write. Reset: 1. 1=Force the on-going prefetch to stop if the address of the pending read is not within the prefetch range for host.
28	PrefetchArbNoSwitch. Read-write. Reset: 1. 1=Only allow prefetch.
27	T_start_fix. Read-write. Reset: 0. BIOS: 1. 1=Enable hand-instance of the pulse generator; allow LPCCLK0/LPCCLK1 to stop under ClkRun# protocol.

26	DisableSpiInSleep. Read-write. Reset: 0. BIOS: 1. 1=SPI signals are driven to low when IMC is not enabled in S3 or S5 and PwrGood goes to low. 0=SPI signals are left high when IMC is not enabled in S3 or S5 and PwrGood goes to low.
25	LpcBusPullUpEn. Read-write. Reset: 0. BIOS: 1. 1=Leave pull-up for LFrame#, LDrq# to be enabled in S0 and disabled in S3/S5 if IMC is not enabled. 0=Force the pull-up for LFrame#, LDrq# to be disabled.
24	PrefetchEnSpiFromHost. Read-write. Reset: 0. BIOS: 1. This is for performance enhancement purpose. 1=SPI controller prefetches from the flash on behalf of the host.
23	PrefetchEnSpiFromUSB. Read-write. Reset: 0. BIOS: 1. This is for performance enhancement purpose. 1=SPI controller prefetches from the flash on behalf of USB3 controller.
22	PrefetchEnSel. Read-write. Reset: 1. 0=Prefetch only the address of the read request that is on the 4 byte boundary. 1=Prefetch only the address of the read request that is on the 8 byte boundary.
21	PrefetchMissEn. Read-write. Reset: 1. 1=Force the on-going prefetch to stop if the address of the pending read is not within the prefetch range for IMC.
20	EcReadOfSwitch. Read-write. Reset: 0. 1=Upper 16 bits of IMC read request address are specified in D14F3xC4 [EcRomRdOffset] . 0=Upper 16 bits of IMC read request address are specified by auto-rom detection logic, see D14F3xCC [AutoRomCfg] for auto-rom detection.
19	EcPortHostAccessEn. Read-write. Reset: 0. 1=Allow host to program D14F3xA4 [EC_PortAddress] .
18	PrefetchEnSpiFromEC. Read-write. Reset: 0. 1=Enable prefetching a cache line (64 bytes) when IMC reads code from the SPI ROM. This bit can be programmed by IMC only.
17	SpiHoldOnGevent9Dis. Read-write. Reset: 0. 0=GEVENT9 and ROM_RST# are configured to SPI_HOLD# and SPI_WP# function. 1=GEVENT9 and ROM_RST# are not configured to SPI_HOLD# and SPI_WP# function.
16	ECPageProtect. Read-write. Reset: 0. Enable protection of the IMC page registers. 1=D14F3x[C7:BC] are only accessible by IMC; host writes have no effect and host reads return 0. 0=D14F3x[C7:BC] are accessible by both IMC and host.
15:6	DWCount. Read-write. Reset: 0. This register specifies the number of cache lines (64 bytes) to be fetched from the ROM when DMA is used.
5:3	Reserved.
2	RomcpSupportAbRetry. Read-write. Reset: 1. 0=ROM copy doesn't support AB retry. 1=ROM copy supports AB retry.
1	DmaErrorStatus. Read; write-1-to-clear. Reset: 0. 1=Previous transfer has error. 0=Previous transfer has completed successfully.
0	DmaStart. Read; write-1-only; cleared-by-hardware. Reset: 0. Writing 1 to this bit causes LPC bridge starts the DMA function, with starting addresses defined by D14F3xB0 and D14F3xB4 . This bit returns the status of the DMA transfer. A return value of 0 means the DMA transfer is complete. A return value of 1 means the DMA transfer is running.

D14F3xC0 EcRomWrOffset

Bits	Description
31:0	EcRomWrOffset. Read-write. Reset: FFF20000h. Specifies the address of IMC write requests. If D14F3xB8[ECPageProtect] == 1, this register returns its current value. If D14F3xB8[ECPageProtect] == 0, this register returns all 0s.

D14F3xC4 EcRomRdOffset

Bits	Description
31:0	EcRomRdOffset. Read-write. Reset: FFF20000h. Specifies the address of IMC read requests. If D14F3xB8[ECPageProtect] == 1, this register returns its current value. If D14F3xB8[ECPageProtect] == 0, this register returns all 0s.

D14F3xC8 ClientRomProtect

Bits	Description
31	AutoSizeStart. Read; write-1-only. Reset: 0. IF (READ) THEN This bit returns the status of Auto-Rom detection. 1=The AutoRom detection is done. 0=AutoRom detection is not done yet. ELSE 1=Trigger AutoRom detection. 0=No effect. ENDIF.
30:8	Reserved.
7:3	Reserved.
2	UsbRomProtectEn. Read-write. Reset: 0. 1=Software cannot access USB portion of the flash.
1	Reserved.
0	EcRomPortectEn. Read-write. Reset: 0. 1=Software cannot access IMC portion of the flash.

D14F3xCC AutoRomCfg

Bits	Description										
31:2	AutoRomAddr. Read-only. Reset: X. Based on the setting of AutoAddressSelect, this register returns the address value detected by the auto-rom detection logic (EcCodeOffset, XhciRomOffset).										
1:0	AutoAddressSelect. Read-write. Reset: 0. The FCH auto detects the IMC and USB3 firmware locations. After detection, it writes the address pointers of each firmware onto bits[31:2]. This field configures which address to be returned on bits[31:2]. <table border="1" data-bbox="267 1312 649 1480"> <thead> <tr> <th>Bits</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>IMC</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>USB XHCI</td></tr> </tbody> </table>	Bits	Definition	00b	Reserved	01b	IMC	10b	Reserved	11b	USB XHCI
Bits	Definition										
00b	Reserved										
01b	IMC										
10b	Reserved										
11b	USB XHCI										

D14F3xD0 ClkCntrl

Bits	Description
31	ClkRunEn. Read-write. Reset: 0. BIOS: 1. 1=ClkRun function is enabled and LPCCLK0/LPCCLK1 can be stopped. 0=ClkRun function is disabled and LPCCLK0/LPCCLK1 can be running all the time.
30:24	ClkRunDlyCounter. Read-write. Reset: 8h. Specifies the amount of clocks to be extended before stopping the LPCCLK0/LPCCLK1.
23	Reserved. Reset: 1.
22	Lclk1ClkrunOvrid. Read-write. Reset: 1. 0=LPCCLK1 will be functioning with CLKRUN protocol. 1=LPCCLK1 will be forced running.

21	Lclk0ClkrunOvrid. Read-write. Reset: 1. 0=LPCCLK0 will be functioning with CLKRUN protocol. 1=LPCCLK0 will be forced running.										
20:15	Reserved. Reset: 3Fh.										
14	Lclk1En. Read-write. Reset: 1. 0=LPCCLK1 will be forced to stop. 1=LPCCLK1 will be functioning with CLKRUN protocol.										
13	Lclk0En. Read-write. Reset: 1. 0=LPCCLK0 will be forced to stop. 1=LPCCLK0 will be functioning with CLKRUN protocol.										
12:3	Reserved. Reset: 3E0h.										
2	ClkRunDisable. Read-write. Reset: 0. 1=CLKRUN# assertion is not allowed; In other words, the internal CLKRUN# coming from LPC is always 0, which means ClkRun logic can never stop the clock.										
1:0	ClkGateCntrl. Read-write. Reset: 2h. These two bits control whether the LPC module allows clock gating to the internal 66MHz core clock. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Disable the clock gating function</td></tr> <tr> <td>01b</td><td>Wait 16 clocks before allowing clock gating to the LPC module</td></tr> <tr> <td>10b</td><td>Wait 64 clocks before allowing clock gating to the LPC module</td></tr> <tr> <td>11b</td><td>Wait 256 clocks before allowing clock gating to the LPC module</td></tr> </table>	Bits	Definition	00b	Disable the clock gating function	01b	Wait 16 clocks before allowing clock gating to the LPC module	10b	Wait 64 clocks before allowing clock gating to the LPC module	11b	Wait 256 clocks before allowing clock gating to the LPC module
Bits	Definition										
00b	Disable the clock gating function										
01b	Wait 16 clocks before allowing clock gating to the LPC module										
10b	Wait 64 clocks before allowing clock gating to the LPC module										
11b	Wait 256 clocks before allowing clock gating to the LPC module										

D14F3xD4 ClkRunOption

Bits	Description
31:8	Reserved.
7:4	MinAssertion. Read-write. Reset: 4h. Specifies the minimum time of ClkRun# assertion. The unit is 30 ns.
3:1	Reserved.
0	ClkRunInputDly. Read-write. Reset: 0. 0=Delay 30 ns before capturing ClkRun# input. 1=Delay 60 ns before capturing ClkRun# input.

3.26.9.2 SPI Registers

SPI configuration registers are accessed through SPI base address specified by [D14F3xA0 \[SPI Base_Addr\]](#). Software can communicate with the SPI ROM through the default memory or alternate program method:

- Memory access to the BIOS ROM address space is automatically handled by the hardware. The SPI ROM controller translates the memory address onto the SPI bus and accesses the SPI ROM data. Any other commands besides memory read or memory write to the SPI ROM need to go through the alternate program method.
- In alternate program method, software needs to program the SpiOpCode, SpiAddress, TxByteCount, RxByteCount, put the data into the transmit FIFO, and then execute the command. The hardware communicates with the SPI ROM using these parameters. This alternate method basically allows software to issue any flash vendor specific commands such as ERASE and STATUS.

SPIx00 SPI_Cntrl0

Bits	Description
31	SpiBusy. Read-only; updated-by-hardware. Reset: 0. 0=SPI bus is idle. 1=SPI bus is busy.

30:29	SpiReadMode[2:1] . Read-write. Reset: 0. This field, along with SpiReadMode[0] below, combine to specify the SPI read mode: <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Normal read (up to 33M)</td></tr> <tr> <td>001b</td><td>Reserved</td></tr> <tr> <td>010b</td><td>Dual IO (1-1-2)</td></tr> <tr> <td>011b</td><td>Quad IO (1-1-4)</td></tr> <tr> <td>100b</td><td>Dual IO (1-2-2)</td></tr> <tr> <td>101b</td><td>Quad IO (1-4-4)</td></tr> <tr> <td>110b</td><td>Normal read (up to 66M)</td></tr> <tr> <td>111b</td><td>Fast Read</td></tr> </table>	Bits	Definition	000b	Normal read (up to 33M)	001b	Reserved	010b	Dual IO (1-1-2)	011b	Quad IO (1-1-4)	100b	Dual IO (1-2-2)	101b	Quad IO (1-4-4)	110b	Normal read (up to 66M)	111b	Fast Read
Bits	Definition																		
000b	Normal read (up to 33M)																		
001b	Reserved																		
010b	Dual IO (1-1-2)																		
011b	Quad IO (1-1-4)																		
100b	Dual IO (1-2-2)																		
101b	Quad IO (1-4-4)																		
110b	Normal read (up to 66M)																		
111b	Fast Read																		
28	SpiClkGate . Read-write. Reset: 0. 1=Skip the 8th SPI clock at the end data when doing read.																		
27	Reserved.																		
26:24	ArbWaitCount . Read-write. Reset: 7h. Specifies the amount of wait time the SPI controller asserts HOLD# before it should access the SPI ROM, under ROM sharing mode with the MAC.																		
23	SpiHostAccessRomEn . Read; write-0-only. Reset: 1. This is a clear-once protection bit; once it is cleared to 0 it cannot be set back to 1. 0=MAC cannot access BIOS ROM space (upper 512KB). 1=MAC can access BIOS ROM space.																		
22	SpiAccessMacRomEn . Read; write-0-only. Reset: 1. This is a clear-once protection bit. 0=Software cannot access MAC's portion of the ROM space (lower 512KB). 1=Software can access MAC's portion of the ROM space.																		
21	IllegalAccess . Read-only; updated-by-hardware. Reset: 0. 0=Legal index mode access. 1=Illegal index mode access.																		
20	FifoPtrClr . RAZ; write-1-only. Reset: 0. Writing 1 to this bit clears the internal FIFO pointer at SPIx0C[FifoPtr] .																		
19	SpiArbEnable . Read-write. Reset: 0. If a MAC is sharing the ROM with the FCH, both chips need to go through an arbitration process before either one can access the ROM. If MAC is not sharing the SPI ROM, BIOS should set this bit to 0 to speed up the SPI ROM access. 1=Enable the arbitration.																		
18	SpiReadMode[0] . Read-write. Reset: 0. Bit 0 of SpiReadMode. See the definition of SpiReadMode[2:1] in this register.																		
17	Reserved.																		
16	ExecuteOpCode . Write-1-only; cleared-by-hardware. Reset: 0. Write 1 to execute the transaction in the alternate program registers. This bit returns to 0 when the transaction is complete. If the command is an illegal command, the bit cannot be set and thereby cannot execute.																		
15:8	Reserved.																		
7:0	SpiOpCode . Read-write. Reset: 0. Specifies the SPI opcode in alternate program method.																		

SPIx04 SPI_RestrictedCmd

Bits	Description
31:24	RestrictedCmd3 . IF (SPIx00[SpiAccessMacRomEn] ==0 SPIx00[SpiHostAccessRomEn] ==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as RestrictedCmd0.
23:16	RestrictedCmd2 . IF (SPIx00[SpiAccessMacRomEn] ==0 SPIx00[SpiHostAccessRomEn] ==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as RestrictedCmd0.

15:8	RestrictedCmd1. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as RestrictedCmd0.
7:0	RestrictedCmd0. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.

SPIx08 SPI_RestrictedCmd2

Bits	Description
31:24	RestrictedCmdWoAddr2. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as [RestrictedCmdWoAddr0] .
23:16	RestrictedCmdWoAddr1. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as [RestrictedCmdWoAddr0] .
15:8	RestrictedCmdWoAddr0. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as SPIx04 [RestrictedCmd0] except that this field defines a restricted command that does not have address.
7:0	RestrictedCmd4. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Same as SPIx04 [RestrictedCmd0].

SPIx0C SPI_Cntrl1

Bits	Description
31:24	ByteCommand. Read-write. Reset: 0. Specifies the command byte for the opcode transaction.
23:22	Reserved.
21:16	WaitCount. Read-write. Reset: 0. Specifies the time unit =15 ns * (WaitCount+1).
15:12	Reserved.
11	TrackMacLockEn. Read-write. Reset: 0. 1=The SPI controller locks the SPI from the MAC when it has detected a command from the MAC matching the value defined in SPIx10 [MacLockCmd0] or SPIx10 [MacLockCmd1]. 0=The SPI controller unlocks the bus when it has detected a command from the MAC matching the value defined in SPIx10 [MacUnlockCmd0] or SPIx10 [MacUnlockCmd1].
10:8	FifoPtr. Read-only. Reset: 0. This specifies the internal pointer location, which can be cleared through SPIx00 [FifoPtrClr].
7:0	SpiParameters. Read-write. Reset: 0. This is the TX/RX FIFO port which can take up to 8 bytes. To send data to SPI ROM, software writes data into this port. To retrieve data that are received from the SPI ROM, software reads from this port.

SPIx10 SPI_CmdValue0

Bits	Description
31:24	MacUnlockCmd1. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 4h. Same as MacUnlockCmd0

23:16	MacUnlockCmd0. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 4h. This field is used to compare against the opcode sent out by the MAC. If SPIx0C [TrackMacLockEn]==1, the controller unlocks the SPI bus for the MAC. In other words, access by the CPU is allowed again.
15:8	MacLockCmd1. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 20h. Same as MacLockCmd0.
7:0	MacLockCmd0. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 6h. This is used to compare against the opcode sent out by the MAC. If SPIx0C [TrackMacLockEn]==1, the controller locks the SPI bus for the MAC. In other words, the MAC has the exclusive access to the ROM and access by the CPU is delayed until this is unlocked. This allows the MAC to do a certain sequence of operations without interruption.

SPIx14 SPI_CmdValue1

Bits	Description
31:24	RDSR. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 5h. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the RDSR (read status register) command from the MAC.
23:16	RDID. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 9Fh. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the RDID (read ID) command from the MAC.
15:8	WRDI. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 4h. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the WRDI (write disable) command from the MAC.
7:0	WREN. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 6h. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the WREN (write enable) command from the MAC.

SPIx18 SPI_CmdValue2

Bits	Description
31:24	BYTEWR. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 2h. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the BYTEWR (byte write) command from the MAC.
23:16	Reserved.
15:8	FRead. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: Bh. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the FRead (fast read) command from the MAC.
7:0	Read. IF (SPIx00 [SpiAccessMacRomEn]==0 SPIx00 [SpiHostAccessRomEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 3h. This is used to compare against the opcode sent out by the MAC. This is a predefined value to decode for the Read (read byte) command from the MAC.

SPIx1C Reserved

Bits	Description
7:0	Reserved. Reset: FFh.

SPIx1D Alt_SPI_CS

Bits	Description										
7	SpiCsDlySel. Read-write. Reset: 0. 1=125 ns minimum SPI_CS# de-assertion time. 0=75 ns minimum SPI_CS# de-assertion time.										
6	Reserved.										
5	SpiProtectLock. Read-write. Reset: 0. 1=bit 3, 4, and 5 are no longer writable.										
4	SpiProtectEn1. IF (SPIx1D [SpiProtectLock]==1) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Enable SPI protection to prevent host from accessing IMC and USB3 space.										
3	SpiProtectEn0. IF (SPIx1D [SpiProtectLock]==1) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Enable SPI read/write protection ranges specified by D14F3x[5C,58,54,50] .										
2	WriteBufferEn. Read-write. Reset: 0. SPI write performance enhancement. 1=SPI bridge can take burst write from the host and transfer it to the SPI flash.										
1:0	AltSpiCsEn. Read-write. Reset: 0. These two bits enable the alternate SPI_CS#. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>select xSPI_CS#</td></tr> <tr> <td>01b</td><td>select xSPI_CS1#</td></tr> <tr> <td>10b</td><td>select xSPI_CS2#</td></tr> <tr> <td>11b</td><td>select xSPI_CS3#</td></tr> </table>	Bits	Definition	00b	select xSPI_CS#	01b	select xSPI_CS1#	10b	select xSPI_CS2#	11b	select xSPI_CS3#
Bits	Definition										
00b	select xSPI_CS#										
01b	select xSPI_CS1#										
10b	select xSPI_CS2#										
11b	select xSPI_CS3#										

SPIx1E SpiExtRegIndx

Bits	Description
7:0	SPI_ExtReg_Indx. Read-write. Reset: 0. Specifies the offset of the extended SPI register to be read/written from SPIx1F [SpiExtRegData] .

SPIx1F SpiExtRegData

Bits	Description
7:0	SPI_ExtReg_Data. Read-write. Reset: 00h. Specifies the read data or write data of the extended SPI register.

SPIx1F_x00 DDR_CMD

Bits	Description
7:0	DDR_CMD. Read-write. Reset: 3Bh. Specifies the command value to be used when host is doing a Dual Output Read.

SPIx1F_x01 QDR_CMD

Bits	Description
7:0	QDR_CMD . Read-write. Reset: 6Bh. Specifies the command value to be used when host is doing a Quad Output Read.

SPIx1F_x02 DPR_CMD

Bits	Description
7:0	DPR_CMD . Read-write. Reset: BBh. Specifies the command value to be used when host is doing a Dual IO High Performance Read.

SPIx1F_x03 QPR_CMD

Bits	Description
7:0	QPR_CMD . Read-write. Reset: EBh. Specifies the command value to be used when host is doing a Quad IO High Performance Read.

SPIx1F_x04 ModeByte

Bits	Description
7:0	ModeByte . Read-write. Reset: 0.

SPIx1F_x05 TxByteCount

Bits	Description
7:0	TxByteCount . Read-write. Reset: 0. Specifies the number of bytes to be sent to SPI ROM.

SPIx1F_x06 RxByteCount

Bits	Description
7:0	RxByteCount . Read-write. Reset: 0. Specifies the number of bytes to be received from the SPI ROM.

SPIx1F_x07 SPIDataFifoPtr

Bits	Description
7:0	SPiDataFiFoPtr . Read-only. Reset: 0. Specifies the current pointer of read/write Data FIFO.

SPIx20 SPI100 Enable

Bits	Description
7:1	Reserved.
0	UseSpi100 . Read-write. Reset: 0. BIOS: see 2.17.4.2. 0=Does not support 100 MHz speed. 1=Supports 100 MHz speed. The actual read speed also depends on SPIx22 .

SPIx22 SPI100 Speed Config

Bits	Description																							
15:12	NormSpeed[3:0] . Read-write. Reset: 0011b . Configures the SPI bus normal speed in SPI100 engine. If the command is not using TpmSpeed and FastSpeed, it will use NormSpeed. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>66.66 MHz</td><td>100b</td><td>100 MHz</td></tr><tr><td>001b</td><td>33.33 MHz</td><td>101b</td><td>800 KHz</td></tr><tr><td>010b</td><td>22.22 MHz</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>16.66 MHz</td><td>111b</td><td>Reserved</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	66.66 MHz	100b	100 MHz	001b	33.33 MHz	101b	800 KHz	010b	22.22 MHz	110b	Reserved	011b	16.66 MHz	111b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																					
000b	66.66 MHz	100b	100 MHz																					
001b	33.33 MHz	101b	800 KHz																					
010b	22.22 MHz	110b	Reserved																					
011b	16.66 MHz	111b	Reserved																					
11:8	FastSpeed[3:0] . Read-write. Reset: 0001b. Configures the SPI bus speed for the following command in SPI100 engine: <ul style="list-style-type: none">• FAST READ• DDR READ (1-1-2)• QDR READ (1-1-4)• DPR READ (1-2-2)• QPR READ (1-4-4) <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>66.66 MHz</td><td>100b</td><td>100 MHz</td></tr><tr><td>001b</td><td>33.33 MHz</td><td>101b</td><td>800 KHz</td></tr><tr><td>010b</td><td>22.22 MHz</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>16.66 MHz</td><td>111b</td><td>Reserved</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	66.66 MHz	100b	100 MHz	001b	33.33 MHz	101b	800 KHz	010b	22.22 MHz	110b	Reserved	011b	16.66 MHz	111b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																					
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001b	33.33 MHz	101b	800 KHz																					
010b	22.22 MHz	110b	Reserved																					
011b	16.66 MHz	111b	Reserved																					
7:4	AltSpeed[3:0] . Read-write. Reset: 0011b. Configures the SPI bus speed for the AltOpCode mode in SPI100 engine. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>66.66 MHz</td><td>100b</td><td>100 MHz</td></tr><tr><td>001b</td><td>33.33 MHz</td><td>101b</td><td>800 KHz</td></tr><tr><td>010b</td><td>22.22 MHz</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>16.66 MHz</td><td>111b</td><td>Reserved</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	66.66 MHz	100b	100 MHz	001b	33.33 MHz	101b	800 KHz	010b	22.22 MHz	110b	Reserved	011b	16.66 MHz	111b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																					
000b	66.66 MHz	100b	100 MHz																					
001b	33.33 MHz	101b	800 KHz																					
010b	22.22 MHz	110b	Reserved																					
011b	16.66 MHz	111b	Reserved																					
3:0	TpmSpeed[3:0] . Read-write. Reset: 0011b. Configures the SPI bus speed for TPM read and write in SPI100 engine. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>66.66 MHz</td><td>100b</td><td>100 MHz</td></tr><tr><td>001b</td><td>33.33 MHz</td><td>101b</td><td>800 KHz</td></tr><tr><td>010b</td><td>22.22 MHz</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>16.66 MHz</td><td>111b</td><td>Reserved</td></tr></table>				<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	66.66 MHz	100b	100 MHz	001b	33.33 MHz	101b	800 KHz	010b	22.22 MHz	110b	Reserved	011b	16.66 MHz	111b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																					
000b	66.66 MHz	100b	100 MHz																					
001b	33.33 MHz	101b	800 KHz																					
010b	22.22 MHz	110b	Reserved																					
011b	16.66 MHz	111b	Reserved																					

SPIx40 DDRCmdCode

Bits	Description
7:0	DDR_CMD . Read-write. Reset: 3Bh. This is the shadow register of SPIx1F_x00 .

SPIx41 QDRCmdCode

Bits	Description
7:0	QDR_CMD . Read-write. Reset: 6Bh. This is the shadow register of SPIx1F_x01 .

SPIx42 DPRCmdCode

Bits	Description
7:0	DPR_CMD . Read-write. Reset: BBh. This is the shadow register of SPIx1F_x02 .

SPIx43 QPRCmdCode

Bits	Description
7:0	QPR_CMD . Read-write. Reset: EBh. This is the shadow register of SPIx1F_x03 .

SPIx44 ModeByte

Bits	Description
7:0	ModeByte . Read-write. Reset: 0. This is the shadow register of SPIx1F_x04 .

SPIx45 CmdCode

Bits	Description
7:0	SpiOpCode . Read-write. Reset: 0. This is the shadow register of SPIx00[SpiOpCode] .

SPIx47 CmdTrigger

Bits	Description
7	Excute . Write-1-only; cleared-by-hardware. Reset: 0. This bit is the shadow register of SPIx00[ExcuteOpCode] .
6:0	Reserved.

SPIx48 TxByteCount

Bits	Description
7:0	TxByteCount . Read-write. Reset: 0. This is the shadow register of SPIx1F_x05 .

SPIx4B RxByteCount

Bits	Description
7:0	RxByteCount . Read-write. Reset: 0. This is the shadow register of SPIx1F_x06 .

SPIx4C SpiStatus

Bits	Description
31	SpiBusy . Read-only; updated-by-hardware. Reset: 0. 1=SPI bus is busy. 0=SPI bus is idle.
30:23	Reserved.
22:16	FiFoRdPtr . Read-only; updated-by-hardware. Reset: 0. The current Data FIFO read pointer.
15	Reserved.
14:8	FiFoWrPtr . Read-only; updated-by-hardware. Reset: 0. The current Data FIFO write pointer.
7:0	DoneByteCount . Read-only; updated-by-hardware. Reset: 0. Indicates how many bytes has been received or sent in the previous SPI transaction.

SPIx[C6:80] FIFO[70:0]

Bits	Description
7:0	FiFo . Read-write. Reset: 0. Contains the Data FiFo byte which is used in command mode to send or receive data.

3.26.10 High Precision Event Timer (HPET) Registers

HPET registers are accessed through two methods:

- Memory access to HPET memory address range from FED0_0000h to FED0_01FFh. Program [PMx00](#)[HpetEn]=1 to enable HPET decoding.
- Memory mapped access through the AcpiMmio region. The HPET registers range from FED8_0000h+C00h to FED8_0000h+CFFh. See [PMx04](#)[MmioEn].

HPETx000 ID

Bits	Description
31:16	VendorID . Read-only. Reset: 1022h.
15	LegacyCap . Read-only. Reset: 1. Legacy replacement interrupt is supported.
14	Reserved.
13	CounterSizeCap . Read-only. Reset: 0. Main counter is 32-bits wide and cannot operate in 64-bit mode.
12:8	NumTmrCap . Read-only. Reset: 2h. Three timers are supported.
7:0	RevID . Read-only. Reset: 01h. Revision ID.

HPETx004 ClkPeriod

Bits	Description
31:0	CounterClkPeriod . Read-only; updated-by-hardware. Reset: 429B17Eh. Specifies the clock period of each HPET timer tick. HPET main counter runs at 14.31818 MHz. The unit is femtosecond (10^{-15} seconds). The value of this register can be modified through MISCx74 .

HPETx010 Config

Bits	Description
31:2	Reserved.
1	LegacyEn . Read-write. Reset: 0. 1=Timer0 interrupt goes to IRQ0 of PIC controller, INT2 of IOAPIC; Timer1 interrupt goes to IRQ8 of PIC controller, INT8 of IOAPIC.
0	TmrEn . Read-write. Reset: 0. 0=Pause main counter and disable all timer interrupts. 1=Allow main counter to run and allow timer interrupts if enabled.

HPETx020 Interrupt Status

Bits	Description
31:3	Reserved.
2	Tmr2IntrSts . IF (HPETx140[TmrIntTyp]==1) THEN Read; set-by-hardware; write-1-to-clear. ELSE Read-write. ENDIF. Reset: 0. 0=Timer2 interrupt is not active. 1=Timer2 interrupt is active. If Timer2 is set to edge-triggered mode, software should ignore this bit and always write 0 to this bit.

1	Tmr1IntrSts. IF (HPETx120[TmrIntTyp]==1) THEN Read; set-by-hardware; write-1-to-clear. ELSE Read-write. ENDIF. Reset: 0. 0=Timer1 interrupt is not active. 1=Timer1 interrupt is active. If Timer1 is set to edge-triggered mode, software should ignore this bit and always write 0 to this bit.
0	Tmr0IntrSts. IF (HPETx100[TmrIntTyp]==1) THEN Read; set-by-hardware; write-1-to-clear. ELSE Read-write. ENDIF. Reset: 0. 0=Timer0 interrupt is not active. 1=Timer0 interrupt is active. If Timer0 is set to edge-triggered mode, software should ignore this bit and always write 0 to this bit.

HPETx0F0 Main Counter

Bits	Description
63:32	MainCounterHi. Read-write. Reset: 0. IF (PMx00[HpetWidthSel]==1) THEN Specifies the upper 32 bits of the 64-bit HPET main counter. Bits [31:0] contain the lower 32 bits of the 64-bit HPET main counter. Should be written to only when it is halted. ELSE Reserved. ENDIF.
31:0	MainCounter. Read-write. Reset: 0. Specified the HPET main counter, incremented by 1 on every clock. Should be written to only when it is halted.

HPETx1[4:0:Step2]0 Timer[2:0] Config Capability

Bits	Description
63:32	TmrIntRouteCap. Read-only. Reset: C00000h. Indicates which INT entry of IOAPIC can be assigned to the timer interrupt.
31:16	Reserved.
15	TmrFsbCap. Read-only. Reset: 1. 1=Front side bus delivery is supported.
14	TmrFsbEn. Read-write. Reset: 0. 1=Enable front side bus delivery of interrupt.
13:9	TmrIntRoute. Read-write. Reset: 0. This specifies which INT entry of IOAPIC the timer is routed to if HPETx010[LegacyEn] == 0.
8	Tmr32ModeEn. Read-only. Reset: 0. 0=64-bit timer is not supported.
7	Reserved.
6	TmrSetPer. Read-write; updated-by-hardware. Reset: 0. 1=Allow software to set the timer's accumulator if the timer is set to periodic mode. The bit is automatically cleared when HPETx1[4:0:Step2]8 [Timer[2:0] Comparator] is written by software.
5	TmrSizeCap. Read-only. Reset: 0. The timer is 32-bits wide.
4	TmrTypCap. Read-only. Reset: 1. The timer supports periodic interrupt delivery mode.
3	TmrTyp. Read-write. Reset: 0. Selects the timer interrupt type. 0=Non-periodic. 1=Periodic.
2	TmrIntEn. Read-write. Reset: 0. 1=Enable the timer interrupt.
1	TmrIntTyp. Read-write. Reset: 0. Specifies the timer interrupt polarity. 0=Edge triggered. 1=Level triggered.
0	Reserved.

HPETx1[4:0:Step2]8 Timer[2:0] Comparator

Bits	Description
63:32	ComparatorHi . Read-write. IF (PMx00[HpetWidthSel]==1) THEN Reset: FFFF_FFFFh. ELSE Reset: 0000_0000h. ENDIF. Specifies the upper 32 bits of the 64-bit timer comparator. Bits [31:0] contain the lower 32 bits of the 64-bit timer comparator. ELSE Reset: 0. Reserved. ENDIF.
31:0	Comparator . IF (HPETx1[4:0:Step2]0[TmrTyp] == 0) THEN Read-write. ELSEIF ((HPETx1[4:0:Step2]0[TmrTyp] == 1) && (HPETx1[4:0:Step2]0[TmrSetPer] == 1)) THEN Read-write. ELSE Read-only. ENDIF. Reset: FFFF_FFFFh. Comparator is periodically incremented by the value last written to this register. This register is updated by hardware when (HPETx1[4:0:Step2]0[TmrTyp] == 1) && the current value in this register matches with the value in HPETx0F0 [Main Counter].

HPETx1[5:1:step2]0 Timer[2:0] FSB Interrupt Data

Bits	Description
31:0	TnFsbIntVal . Read-write. Reset: 00000000h. Software sets this 32-bit field to specify the write data of Front Side Bus (FSB) Interrupt Message.

HPETx1[5:1:step2]4 Timer[2:0] FSB Interrupt Address

Bits	Description
31:0	TnFsbIntAddr . Read-write. Reset: 00000000h. Software sets this 32-bit field to specify the address of Front Side Bus (FSB) Interrupt Message.

HPETx1[D:B]0 Timer[2:0] Comparator Base Shadow

Bits	Description
63:32	TmrCompBaseShadowHi . Read-write. IF (PMx00[HpetWidthSel]==1) THEN Reset: FFFF_FFFFh. ELSE Reset: 0000_0000h. ENDIF. This is shadow of the base value of HPETx1[4:0:Step2]8[ComparatorHi]. Reading this register returns the base value of HPETx1[4:0:Step2]8[ComparatorHi]. Writing the register will change the base value of HPETx1[4:0:Step2]8[ComparatorHi].
31:0	TmrCompBaseShadowLo . Read-write. Reset: FFFF_FFFFh. This is shadow of the base value of HPETx1[4:0:Step2]8[Comparator]. Reading this register returns the base value of HPETx1[4:0:Step2]8[Comparator]. Writing the register will change the base value of HPETx1[4:0:Step2]8[Comparator].

HPETx1[D:B]8 Timer[2:0] Comparator Shadow

Bits	Description
63:32	TmrCompShadowHi . Read-write. IF (PMx00[HpetWidthSel]==1) THEN Reset: FFFF_FFFFh. ELSE Reset: 0000_0000h. ENDIF. This is shadow of the current value of HPETx1[4:0:Step2]8[ComparatorHi]. Reading this register returns the current value of HPETx1[4:0:Step2]8[ComparatorHi]. Writing the register will change the current value of HPETx1[4:0:Step2]8[ComparatorHi].
31:0	TmrCompShadowLo . Read-write. Reset: FFFF_FFFFh. This is shadow of the current value of HPETx1[4:0:Step2]8[Comparator]. Reading this register returns the current value of HPETx1[4:0:Step2]8[Comparator]. Writing the register will change the current value of HPETx1[4:0:Step2]8[Comparator].

HPETx1E0 Main Counter RTC

Bits	Description
63:32	MainCounterRtcHi . Read-write. Reset: 0. IF (PMx00[HpetWidthSel]==1) THEN Specifies the shadow of HPETx0F0[MainCounterHi]. See MainCounterRtcLo. ELSE Reserved. ENDIF.
31:0	MainCounterRtcLo . Read-write. Reset: 0. This is a shadow of HPETx0F0[MainCounter]. It samples the value of Main Counter at every falling edge of RTC 32 KHz clock for software to read. When software writes this register, HPETx0F0[MainCounter] will be updated with the same value written to this register, and then enabled counting at the next RTC clock falling edge. The purpose of this register is for the convenience of SW save/restore HPET.

HPETx1E8 Next Timer Remain

Bits	Description
63:32	NxtTmrRemainHi . Read-write. Reset: 0. IF (PMx00[HpetWidthSel]==1) THEN Specifies the upper 32 bits of the timer ticks remaining before the next enabled comparator interrupt. ELSE Reserved. ENDIF.
31:0	NxtTmrRemainLo . Read-only. Reset: FFFF_FFFFh. Specifies how many timer ticks remaining before the next enabled comparator interrupt.

3.26.11 Miscellaneous (MISC) Registers

MISC register space is accessed through the AcpiMmio region. The MISC registers range from FED8_0000h+E00h to FED8_0000h+EFFh. See [PMx04\[Mmio\]](#).

MISCx00 GPPClkCtrl

BIOS: See [2.17.9.1](#).

Bits	Description																				
31	Reserved.																				
30:27	CG1PLL_VREG_BIAS . Read-write. Reset: 0. Voltage regulator current bias control (Spare).																				
26:25	CG1PLL_VREG_CNTL . Read-write. Reset: 0. Voltage regulator voltage control (Spare).																				
24	CG1PLL_VREG_VREF_SEL . Read-write. Reset: 0. Select Voltage regulator reference (Spare). 0=Bandgap. 1=Resistor Divider.																				
23	CG1PLL_PLLCORE_PWDN_EN . Read-write. Reset: 0. Control for powering down PLL's analog core (including PFD/CP, OTA, VCO, REFGENs, LF and all differential output drivers). It is only used for external clock-chip mode to bypass XTALIN 25 MHz to SATA differentially, when CG1_PLL is required to be off. 0=Disable. 1=Enable.																				
22:19	CGPLL_BG_ADJ . Read-write. Reset: 8. Fine adjust for band-gap. Level shifted inside PLL to 1.8V.																				
18:16	Reserved.																				
15:12	<p>GPP_CLK3_ClockRequestMapping. Read-write. Reset: Fh. GPP3 PCIe clock pins (GPP_CLK3P/GPP_CLK3N) output control by CLK_REQ# pin. GPP_CLK3P/GPP_CLK3N pins are powered off when FCH is strapped to use an external clock, and powered on when FCH is strapped to operate in integrated clock mode. When FCH is in integrated clock mode, GPP3 PCIe clock can be powered off according to the CLK_REQ mapping table below, and the selected CLK_REQ# input can power off the GPP3 PCIe clock output pins if it is asserted.</p> <p>GPP3_CLKREQ_Mapping:</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000b</td><td>Off</td></tr> <tr> <td>0001b</td><td>CLK_REQ0#</td></tr> <tr> <td>0010b</td><td>CLK_REQ1#</td></tr> <tr> <td>0011b</td><td>CLK_REQ2#</td></tr> <tr> <td>0100b</td><td>CLK_REQ3#</td></tr> <tr> <td>1001b-0101b</td><td>Reserved; Off</td></tr> <tr> <td>1010b</td><td>CLK_REQGfx#</td></tr> <tr> <td>1110b-1011b</td><td>Reserved; Off</td></tr> <tr> <td>1111b</td><td>On</td></tr> </table>	Bits	Definition	0000b	Off	0001b	CLK_REQ0#	0010b	CLK_REQ1#	0011b	CLK_REQ2#	0100b	CLK_REQ3#	1001b-0101b	Reserved; Off	1010b	CLK_REQGfx#	1110b-1011b	Reserved; Off	1111b	On
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0100b	CLK_REQ3#																				
1001b-0101b	Reserved; Off																				
1010b	CLK_REQGfx#																				
1110b-1011b	Reserved; Off																				
1111b	On																				

11:8	<p>GPP_CLK2_ClockRequestMapping. Read-write. Reset: Fh. GPP2 PCIe clock pins (GPP_CLK2P/GPP_CLK2N) output control by CLK_REQ# pin. GPP_CLK2P/GPP_CLK2N pins are powered off when FCH is strapped to use an external clock, and powered on when FCH is strapped to operate in integrated clock mode. When FCH is in integrated clock mode, GPP2 PCIe clock can be powered off according to the CLK_REQ mapping table below, and the selected CLK_REQ# input can power off the GPP2 PCIe clock output pins if it is asserted.</p> <p>GPP2_CLKREQ_Mapping:</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0000b</td><td>Off</td></tr> <tr> <td>0001b</td><td>CLK_REQ0#</td></tr> <tr> <td>0010b</td><td>CLK_REQ1#</td></tr> <tr> <td>0011b</td><td>CLK_REQ2#</td></tr> <tr> <td>0100b</td><td>CLK_REQ3#</td></tr> <tr> <td>1001b-0101b</td><td>Reserved; Off</td></tr> <tr> <td>1010b</td><td>CLK_REQGfx#</td></tr> <tr> <td>1110b-1011b</td><td>Reserved; Off</td></tr> <tr> <td>1111b</td><td>On</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0000b	Off	0001b	CLK_REQ0#	0010b	CLK_REQ1#	0011b	CLK_REQ2#	0100b	CLK_REQ3#	1001b-0101b	Reserved; Off	1010b	CLK_REQGfx#	1110b-1011b	Reserved; Off	1111b	On
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1010b	CLK_REQGfx#																				
1110b-1011b	Reserved; Off																				
1111b	On																				

7:4	<p>GPP_CLK1_ClockRequestMapping. Read-write. Reset: Fh. GPP1 PCIe clock pins (GPP_CLK1P/GPP_CLK1N) output control by CLK_REQ# pin. GPP_CLK1P/GPP_CLK1N pins are powered off when FCH is strapped to use an external clock and powered on when FCH is strapped to operate in integrated clock mode. When FCH is in integrated clock mode, GPP1 PCIe clock can be powered off according to the CLK_REQ mapping table below, and the selected CLK_REQ# input can power off GPP1 PCIe clock output pins if it is asserted.</p> <p>GPP1_CLKREQ_Mapping:</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000b</td><td>Off</td></tr> <tr> <td>0001b</td><td>CLK_REQ0#</td></tr> <tr> <td>0010b</td><td>CLK_REQ1#</td></tr> <tr> <td>0011b</td><td>CLK_REQ2#</td></tr> <tr> <td>0100b</td><td>CLK_REQ3#</td></tr> <tr> <td>1001b-0101b</td><td>Reserved; Off</td></tr> <tr> <td>1010b</td><td>CLK_REQGfx#</td></tr> <tr> <td>1110b-1011b</td><td>Reserved; Off</td></tr> <tr> <td>1111b</td><td>On</td></tr> </table>	Bits	Definition	0000b	Off	0001b	CLK_REQ0#	0010b	CLK_REQ1#	0011b	CLK_REQ2#	0100b	CLK_REQ3#	1001b-0101b	Reserved; Off	1010b	CLK_REQGfx#	1110b-1011b	Reserved; Off	1111b	On
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1010b	CLK_REQGfx#																				
1110b-1011b	Reserved; Off																				
1111b	On																				
3:0	<p>GPP_CLK0_ClockRequestMapping. Read-write. Reset: Fh. GPP0 PCIe clock pins (GPP_CLK0P/GPP_CLK0N) output control by CLK_REQ# pin. GPP_CLK0P/GPP_CLK0N pins are powered off when FCH is strapped to use an external clock and powered on when FCH is strapped to operate in integrated clock mode. When FCH is in integrated clock mode, GPP0 PCIe clock can be powered off according to the CLK_REQ mapping table below, and the selected CLK_REQ# input can power off the GPP0 PCIe clock output pins if it is asserted.</p> <p>GPP0_CLKREQ_Mapping:</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000b</td><td>Off</td></tr> <tr> <td>0001b</td><td>CLK_REQ0#</td></tr> <tr> <td>0010b</td><td>CLK_REQ1#</td></tr> <tr> <td>0011b</td><td>CLK_REQ2#</td></tr> <tr> <td>0100b</td><td>CLK_REQ3#</td></tr> <tr> <td>1001b-0101b</td><td>Reserved; Off</td></tr> <tr> <td>1010b</td><td>CLK_REQGfx#</td></tr> <tr> <td>1110b-1011b</td><td>Reserved; Off</td></tr> <tr> <td>1111b</td><td>On</td></tr> </table>	Bits	Definition	0000b	Off	0001b	CLK_REQ0#	0010b	CLK_REQ1#	0011b	CLK_REQ2#	0100b	CLK_REQ3#	1001b-0101b	Reserved; Off	1010b	CLK_REQGfx#	1110b-1011b	Reserved; Off	1111b	On
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1001b-0101b	Reserved; Off																				
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1110b-1011b	Reserved; Off																				
1111b	On																				

MISCx04 ClkOutputCntrl

Bits	Description
31	CG2_RegulatorOff. Read-write. Reset: 0. 1=Turn off CG2_PLL Regulator.
30	CG1_RegulatorOff. Read-write. Reset: 0. 1=Turn off CG1_PLL Regulator.
29	Reserved.
28	PciePhyRefClkPwDn. Read-write. Reset: 0. 1=Power-off Clkgen_outpad 100Mhz CML reference clock for PCIE_PHY.
27	CLKGEN_TestClkPwDn. Read-write. Reset: 0. 1=Power off Clkgen_outpad TestClk Output buffer.

26	EXT_CLK_ClockSourceOverride. Read-write. Reset: 0. EXT_CLK clock source override control. EXT_CLK clock source is controlled by strap (LPCCLK1). If Strap (LPCCLK1) == 1, clock source is from CG_PLL. If Strap (LPCCLK1) == 0, clock source is from external clock chip through GPP_CLK3_P/N pins. This override bit allows to invert the strap that controls EXT_CLK clock source. 0=Use the strap value (LPCCLK1) to determine whether EXT_CLK clock source from either CG_PLL or external clock chip. 1=Invert the strap that controls EXT_CLK clock source.										
25	CG2PLL_CoreClkOutputEn. Read-write. Reset: 1. CG2_PLL Core Clock (400 MHz) Output Enable. 0=Clock Output Buffer disable. 1=Clock Output Buffer Enable.										
24:23	CG1PLL_DS_Order. Read-write. Reset: 1. DS order setting. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>disable</td></tr> <tr> <td>01b</td><td>1st order</td></tr> <tr> <td>10b</td><td>2nd order</td></tr> <tr> <td>11b</td><td>3rd order</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	disable	01b	1st order	10b	2nd order	11b	3rd order
<u>Bits</u>	<u>Definition</u>										
00b	disable										
01b	1st order										
10b	2nd order										
11b	3rd order										
22	CG1PLL_DS_PrbsEn. Read-write. Reset: 1. 1=Enable CG1_PLL PRBS17 generator in DS modulator.										
21:20	CG1PLL_FBDIV_FractionCtl. Read-write. Reset: 1. CG1_PLL Slip Req/Ack handshaking control: <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Slip_req/Slip_ack handshake (8 VCO clock cycles per slip)</td></tr> <tr> <td>01b</td><td>Slip once every clock cycle (ignore slip_ack)</td></tr> <tr> <td>10b</td><td>Slip once every 2 clock cycles (ignore slip_ack)</td></tr> <tr> <td>11b</td><td>Slip once every 4 clock cycles (ignore slip_ack)</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Slip_req/Slip_ack handshake (8 VCO clock cycles per slip)	01b	Slip once every clock cycle (ignore slip_ack)	10b	Slip once every 2 clock cycles (ignore slip_ack)	11b	Slip once every 4 clock cycles (ignore slip_ack)
<u>Bits</u>	<u>Definition</u>										
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10b	Slip once every 2 clock cycles (ignore slip_ack)										
11b	Slip once every 4 clock cycles (ignore slip_ack)										
19:17	Reserved.										
16	ClockBufferBiasPowerDownEnable. Read-write. Reset: 1. 1=Power down the clock buffers bias current circuit for power saving.										
15:14	Reserved.										
13	PCIE_RCLK_PowerDownEnable. Read-write. Reset: 0. BIOS: See 2.17.9.1. 1=Power down PCIE_RCLK input buffer for power saving.										
12	GFX_GPP_CLK_ClockOutputOverride: GFX_GPP_CLK [2:0] ClockOutputOverride. Read-write. Reset: 0. GFX_GPP_CLK[2:0] clock output override control. GFX_CLK and GPP_CLK[2:0] clock outputs are controlled by [SLT_GFX_CLKClockRequestMapping] and MISCx00[GPP_CLK0_ClockRequestMapping, GPP_CLK1_ClockRequestMapping, GPP_CLK2_ClockRequestMapping] . Basically it depends on whether chip is in internal (Strap (LPCCLK1) = 1) or external (Strap (LPCCLK1) = 0) clock mode. This override bit allows to invert the strap value that controls clock output buffer. 0=Use SLT_GFX Clock Request mapping and GPP_CLK[2:0] Clock Request mapping to determine whether clock output buffer is on or off. 1=Invert the strap that controls those clock output buffer.										
11	GPP_CLK3_ClockOutputOverride. Read-write. Reset: 0. GPP_CLK3 clock output override control. GPP_CLK3 is a bi-directional pin depending on LPCCLK1 strap value. If Strap (LPCCLK1) = 1, GPP_CLK3 provides clock for external device and output buffer will be on. If Strap (LPCCLK1) = 0, GPP_CLK3 receives clock from external clock chip and output buffer will be off. This override bit allows to invert the strap that controls GPP_CLK3 clock output buffer. 0=Use the strap value (LPCCLK1) to determine whether GPP_CLK3 clock output buffer is on or off. 1=Invert the strap that controls GPP_CLK3 clock output buffer.										

10	CPU_CLK_ClockSourceOverride. Read-write. Reset: 0. CPU_CLK clock source override control. CPU_CLK clock source is controlled by strap (LPCCLK1). If Strap (LPCCLK1) =1, CPU_CLK clock source is from CG_PLL. If Strap (LPCCLK1) =0, CPU_CLK clock source is from external clock chip through GPP_CLK3_P/N pins. This override bit allows to invert the strap that controls CPU_CLK clock source. 0=Use the strap value (LPCCLK1) to determine whether CPU_CLK clock source from either CG_PLL or external clock chip. 1=Invert the strap that controls CPU_CLK clock source.																				
9:8	Reserved.																				
7:4	SLT_GFX_CLK_ClockRequestMapping. Read-write. Reset: Fh. Gfx PCIe clock pins (SLT_GFX_CLKP/SLT_GFX_CLKN) output control. SLT_GFX_CLKP/SLT_GFX_CLKN pins are powered off when FCH is strapped to use an external clock, and powered on when FCH is strapped to operate in integrated clock mode. When FCH is in integrated clock mode, Gfx PCIe clock can be powered off according to the CLK_REQ mapping table below, and the selected CLK_REQ# input can power off Gfx PCIe clock output pins if it is asserted. Gfx_CLKREQ_Mapping: <table> <thead> <tr> <th>Bits</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>0000b</td><td>Off</td></tr> <tr> <td>0001b</td><td>CLK_REQ0#</td></tr> <tr> <td>0010b</td><td>CLK_REQ1#</td></tr> <tr> <td>0011b</td><td>CLK_REQ2#</td></tr> <tr> <td>0100b</td><td>CLK_REQ3#</td></tr> <tr> <td>1001b-0101b</td><td>Reserved; Off</td></tr> <tr> <td>1010b</td><td>CLK_REQGfx#</td></tr> <tr> <td>1110b-1011b</td><td>Reserved; Off</td></tr> <tr> <td>1111b</td><td>On</td></tr> </tbody> </table>	Bits	Definition	0000b	Off	0001b	CLK_REQ0#	0010b	CLK_REQ1#	0011b	CLK_REQ2#	0100b	CLK_REQ3#	1001b-0101b	Reserved; Off	1010b	CLK_REQGfx#	1110b-1011b	Reserved; Off	1111b	On
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1001b-0101b	Reserved; Off																				
1010b	CLK_REQGfx#																				
1110b-1011b	Reserved; Off																				
1111b	On																				
3:2	CG1PLL_LOCK_FREQ_SEL. Read-write. Reset: 0. CG1_PLL VCO centre frequency selection for calibration. <table> <thead> <tr> <th>Bits</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>00b</td><td>set VCO centre at 1200 MHz</td></tr> <tr> <td>01b</td><td>set VCO centre at 1000 MHz</td></tr> <tr> <td>10b</td><td>set VCO centre at 800 MHz</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </tbody> </table>	Bits	Definition	00b	set VCO centre at 1200 MHz	01b	set VCO centre at 1000 MHz	10b	set VCO centre at 800 MHz	11b	Reserved										
Bits	Definition																				
00b	set VCO centre at 1200 MHz																				
01b	set VCO centre at 1000 MHz																				
10b	set VCO centre at 800 MHz																				
11b	Reserved																				
1	CG1PLL_BYPASS_CAL. Read-write. Reset: 0. CG1_PLL Calibration bypass enable. 0=Always do VCO calibration after a reset. 1=Bypass VCO calibration after a reset.																				
0	CG1PLL_CAL_BYPASS_REFDIV_EN. Read-write. Reset: 0. CG1_PLL Calibration reference divider bypass enable. 0=Reference divider set by MISCx10 [CG1PLL_CAL_REFDIV] during calibration. 1=Bypass reference divider during calibration.																				

MISCx08 CGPLLConfig1

Bits	Description
31:16	CG1PLL_DS_Frac. Read-write. Reset: 0. CG1_PLL DS fractional setting.
15:11	Reserved.
10	CG2PLL_Reset. Read-write; Cleared-by-hardware. Reset: 0. 1=Reset the CG2 _PLL. The bit will be cleared to 0 by hardware after reset sequence is done.
9	Reserved.

8:6	Reserved.
5	Cg1PllSataClkBypass . Read-write. Reset: 0. SATA clock source frequency select from CG1_PLL. SATA reference clock output from CG1_PLL has an option for either output 100Mhz or bypass CG1_PLL RefClk input. 0=PLL 100Mhz. 1=Bypass CG1_PLL RefClk input (48Mhz or 100Mhz)
4	Reserved.
3	Reserved.
2:1	Reserved.
0	CG1PLL_SpreadSpectrumEnable . Read-write. Reset: 0. 1=Enable CG1_PLL Spread Spectrum. 0=Disable Spread Spectrum.

MISCx0C CGPLLConfig2

Bits	Description															
31:25	CG1PLL_PDIV_PCIECLK. Read-write. Reset: 12h. CG1_PLL 100 MHz clock post divider (PCIe and SATA clock). <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>0h</td><td>Bypass</td></tr><tr><td>1h</td><td>Bypass</td></tr><tr><td>7Fh-02h</td><td>Divide by <CG1PLL_PDIV_PCIECLK></td></tr></table>				Bits	Definition	0h	Bypass	1h	Bypass	7Fh-02h	Divide by <CG1PLL_PDIV_PCIECLK>				
Bits	Definition															
0h	Bypass															
1h	Bypass															
7Fh-02h	Divide by <CG1PLL_PDIV_PCIECLK>															
24:18	CG1PLL_PDIV_CoreCLK. Read-write. Reset: 03h. CG1_PLL 400 MHz clock post divider (core clock). <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>0h</td><td>Bypass</td></tr><tr><td>1h</td><td>Bypass</td></tr><tr><td>7Fh-02h</td><td>Divide by <CG1PLL_PDIV_CoreCLK></td></tr></table>				Bits	Definition	0h	Bypass	1h	Bypass	7Fh-02h	Divide by <CG1PLL_PDIV_CoreCLK>				
Bits	Definition															
0h	Bypass															
1h	Bypass															
7Fh-02h	Divide by <CG1PLL_PDIV_CoreCLK>															
17:16	SATA_REFIN_ClkBufDrvStr. Read-write. Reset: 01b. Specifies the drive strength control for internal SATA RefClk input differential clock buffers (from CLKGEN to SATA_PHY). <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>6X driving</td><td>10b</td><td>10X driving</td></tr><tr><td>01b</td><td>8X driving</td><td>11b</td><td>12X driving</td></tr></table>				Bits	Definition	Bits	Definition	00b	6X driving	10b	10X driving	01b	8X driving	11b	12X driving
Bits	Definition	Bits	Definition													
00b	6X driving	10b	10X driving													
01b	8X driving	11b	12X driving													
15:14	USB2_REFIN_ClkBufDrvStr. Read-write. Reset: 01b. Specifies the drive strength control for internal USB2 RefClk input differential clock buffers (from CLKGEN to USB2_PHY). <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>1.5X driving</td><td>10b</td><td>3X driving</td></tr><tr><td>01b</td><td>2X driving</td><td>11b</td><td>3.5X driving</td></tr></table>				Bits	Definition	Bits	Definition	00b	1.5X driving	10b	3X driving	01b	2X driving	11b	3.5X driving
Bits	Definition	Bits	Definition													
00b	1.5X driving	10b	3X driving													
01b	2X driving	11b	3.5X driving													
13:12	USB3_REFIN_ClkBufDrvStr. Read-write. Reset: 01b. Specifies the drive strength control for internal USB3 RefClk input differential clock buffers (from CLKGEN to USB3_PHY). <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>2X driving</td><td>10b</td><td>4X driving</td></tr><tr><td>01b</td><td>3X driving</td><td>11b</td><td>5X driving</td></tr></table>				Bits	Definition	Bits	Definition	00b	2X driving	10b	4X driving	01b	3X driving	11b	5X driving
Bits	Definition	Bits	Definition													
00b	2X driving	10b	4X driving													
01b	3X driving	11b	5X driving													
11:10	PCIe_REFIN_ClkBufDrvStr. Read-write. Reset: 01b. Specifies the drive strength control for internal PCIe RefClk input differential clock buffers (from CLKGEN to PCIe). <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>2X driving</td><td>10b</td><td>4X driving</td></tr><tr><td>01b</td><td>3X driving</td><td>11b</td><td>5X driving</td></tr></table>				Bits	Definition	Bits	Definition	00b	2X driving	10b	4X driving	01b	3X driving	11b	5X driving
Bits	Definition	Bits	Definition													
00b	2X driving	10b	4X driving													
01b	3X driving	11b	5X driving													

9:8	CGPLL_REFIN_ClkBufDrvStr. Read-write. Reset: 01b. Specifies the drive strength control for CGPLL external refclk input differential clock buffers (from CLKGEN to CGPLL).			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	1.5X driving	10b	3X driving
	01b	2X driving	11b	3.5X driving
7:6	Reserved.			
5:2	Reserved.			
1:0	Cg1BgVrefBias. Read-write. Reset: 0. Specifies the CGPLL voltage regulator current bias control from Bandgap VREG_BIAS[1:0].			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	100 uA	10b	75 uA
	01b	120 uA	11b	85 uA

MISCx10 CGPLLConfig3

Bits	Description
31:30	Reserved.
29:26	CG1PLL_CAL_REFDIV. Read-write. Reset: 0100b. Calibration reference divider control. It is only used when MISCx04 [CG1PLL_CAL_BYPASS_REFDIV_EN] == 0. <u>Bits</u> <u>Definition</u> 0h invalid 1h invalid Fh-2h Divide by <CG1PLL_CAL_REFDIV>
25:22	CG1PLL_FBDIV_Fraction. Read-write. Reset: 0. Fractional part setting of the CG1_PLL feedback divider value. <u>Bits</u> <u>Definition</u> 0 0 9-1 <CG1PLL_FBDIV_Fraction*0.1> 15-10 0
21:10	CG1PLL_FBDIV. Read-write. Reset: 50. Integer part setting of the CG1_PLL Feedback divider value. <u>Bits</u> <u>Definition</u> 0 Divide by 2 1 Divide by 2 FFFh-2h Divide by <CG1PLL_FBDIV>
9:0	CG1PLL_REFDIV. Read-write. Reset: 2. Reference divider control. It is only used after calibration is done. <u>Bits</u> <u>Definition</u> 0 Bypass 1 Bypass 3FFh-2h Divide by <CG1PLL_REFDIV>

MISCx14 CGPLLConfig4

Bits	Description
31:16	CG1PLL_SS_AMOUNT_DSFRAC . Read-write. Reset: 1FFFh. CG1_PLL Spread spectrum amount DS setting.
15:0	CG1PLL_SS_STEP_SIZE_DSFRAC . Read-write. Reset: 16Dh. CG1_PLL Spread spectrum step size DS control.

MISCx18 CGPLLConfig5

Bits	Description										
31:30	Reserved.										
29	CG2PLL_VCO800M_EN . Read-write. Cold reset: 0. 1=Enable CG2_PLL VCO running at 800 MHz. 0=Disable. A warm reset is required after programming this bit to enable/disable VCO running at 800 MHz.										
28:27	Reserved.										
26	CG1PLL_VCO800M_EN . Read-write. Cold reset: 0. 1=Enable CG1_PLL VCO running at 800 MHz. 0=Disable. A warm reset is required after setting this bit to enable/disable VCO running at 800 MHz.										
25:24	CG1PLL_PCALREF . Read-write. Reset: 0. CG1_PLL VCO input2 control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>close loop configuration</td></tr> <tr> <td>1</td><td>1/3 supply voltage</td></tr> <tr> <td>2</td><td>1/2 supply voltage</td></tr> <tr> <td>3</td><td>2/3 supply voltage</td></tr> </table>	Bits	Definition	0	close loop configuration	1	1/3 supply voltage	2	1/2 supply voltage	3	2/3 supply voltage
Bits	Definition										
0	close loop configuration										
1	1/3 supply voltage										
2	1/2 supply voltage										
3	2/3 supply voltage										
23:22	CG1PLL_PVCOREF . Read-write. Reset: 0. CG1_PLL VCO input1 control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>close loop configuration</td></tr> <tr> <td>1</td><td>1/3 supply voltage</td></tr> <tr> <td>2</td><td>1/2 supply voltage</td></tr> <tr> <td>3</td><td>2/3 supply voltage</td></tr> </table>	Bits	Definition	0	close loop configuration	1	1/3 supply voltage	2	1/2 supply voltage	3	2/3 supply voltage
Bits	Definition										
0	close loop configuration										
1	1/3 supply voltage										
2	1/2 supply voltage										
3	2/3 supply voltage										
21:13	Reserved.										
12	CG1PLL_SS_MODE . Read-write. Reset: 1. CG1_PLL Spread spectrum mode select. 0=Center spread. 1=Down spread.										
11:8	CG1PLL_SS_AMOUNT_NFRAC_SLIP . Read-write. Reset: 2. CG1_PLL Spread spectrum amount fractional setting.										
7:0	CG1PLL_SS_AMOUNT_FBDIV . Read-write. Reset: 0. CG1_PLL Spread spectrum amount setting.										

MISCx1C CGPLLConfig6

BIOS: See [2.17.9.3 \[CG_PLL CMOS Clock Driver Setting for Power Saving\]](#).

Bits	Description
31:30	Reserved.

29	CgpllClkDriverUpdate. Read-write. Cold Reset: 0. CGPLL clock output drive type update. CGPLL has CML and CMOS type of clock output drivers. The selections are in MISCx1C[28:21] . 0=CG_PLL clock driver type selection only gets updated from MISCx1C[28:21] when CG_PLL got reset. 1=CG_PLL clock driver type selection gets updated on the fly from MISCx1C[28:21] .										
28:25	Cg1RefClk48MHzDriverType. Read-write. Cold Reset: 0010b. Selects CG1_PLL RefClk 48Mhz clock driver type. For each bit, 0=CML type clock driver. 1=CMOS type clock driver (consume less power). <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>Reserved</td></tr> <tr> <td>[1]</td><td>Buf48 MHz for USB2 and SATA</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>Reserved</td></tr> </table>	Bit	Definition	[0]	Reserved	[1]	Buf48 MHz for USB2 and SATA	[2]	Reserved	[3]	Reserved
Bit	Definition										
[0]	Reserved										
[1]	Buf48 MHz for USB2 and SATA										
[2]	Reserved										
[3]	Reserved										
24:21	Cg1ClkDriverType. Read-write. Cold Reset: 1011b. Selects CG1_PLL clock driver type. For each bit, 0=CML type clock driver. 1=CMOS type clock driver (consume less power). <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>USB</td></tr> <tr> <td>[1]</td><td>SATA</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>PCIe</td></tr> </table>	Bit	Definition	[0]	USB	[1]	SATA	[2]	Reserved	[3]	PCIe
Bit	Definition										
[0]	USB										
[1]	SATA										
[2]	Reserved										
[3]	PCIe										
20	SataRefClkSrc. Read-write. Reset: 0. Selects SATA reference clock source. 0=SATA reference clock is from CG XTAL 48 Mhz non-spread. 1=Reserved.										
19:18	Reserved.										
17:9	CG1PLL_LF_MODE. Read-write. Reset: 0FEh. CG1_PLL Loop filter control. It defines the setting of loop filter R and C values.										
8	CG2PLL_RefClk_Sel. Read-write. Reset: 1. CG2_PLL reference clock select. 0=100 MHz from external clock chip. 1=25 MHz from XTAL.										
7	Force25mXtalPadPwdn. Read-write. Reset: 0. Force 25M XTAL Pad Power Down. Set this bit and MISCx40[Pwdown25Mxtal] to 1 to power down 25 MHz XTAL Pad										
6	CG2PLL_PWDN_FORCE. Read-write. Reset: 0. Force CG2_PLL Power Down.										
5	Reserved.										
4:0	CG1PLL_CAL_MODE. Read-write. Reset: 5. CG1_PLL VCO calibration mode control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0xxxxb</td><td>VCO mode set to calibrated values</td></tr> <tr> <td>1xxxxb</td><td>VCO mode forced to the value set in CG1PLL_CAL_MODE[3:0]</td></tr> </table>	Bits	Definition	0xxxxb	VCO mode set to calibrated values	1xxxxb	VCO mode forced to the value set in CG1PLL_CAL_MODE[3:0]				
Bits	Definition										
0xxxxb	VCO mode set to calibrated values										
1xxxxb	VCO mode forced to the value set in CG1PLL_CAL_MODE[3:0]										

MISCx20 IMPCalibration

Bits	Description
31:26	CG1PLL_SPARE. Read-write. Reset: 0. CG1_PLL general spare pins.
25:23	Reserved.
22:20	CG1PLL_DIG_SPARE. Read-write. Reset: 0. CG1_PLL digital block spare pins.
19	CG1PLL_SATA_CLK_CUSTOM_PDIV_EN. Read-write. Reset: 1. CG1_PLL CLKOUT3B (SATA 100 MHz) Post-dividers selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.

18	CG1PLL_PCIE_CLK_CUSTOM_PDIV_EN. Read-write. Reset: 1. CG1_PLL CLKOUT3A (PCIe 100 MHz) post divider selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.			
17	CG1PLL_USB2CLK_CUSTOM_PDIV_EN. Read-write. Reset: 0. CG1_PLL CLKOUT2 (USB 48 MHz) post divider selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.			
16	CG1PLL_CLKOUT3A_PDIVSEL. Read-write. Reset: 1. CG1_PLL PCIe clock select between Ref-Clk (input of reference divider) and post divider 3. 0=Input of reference divider. 1=PDIV3 Output.			
15	CG1PLL_CLKOUT2_PDIVSEL. Read-write. Reset: 1. CG1_PLL USB2 clock select between Ref-Clk (input of reference divider) and post divider 2. 0=Input of reference divider. 1=PDIV2 Output.			
14	CG1PLL_CLKOUT1_PDIVSEL. Read-write. Reset: 1. CG1_PLL Core Clock select between Ref-Clk (input of reference divider) and post divider 1. 0=Input of reference divider. 1=PDIV1 Output.			
13:12	CG1PLL_PFD_PULSE_SEL. Read-write. Reset: 2. CG1_PLL Change reset pulse inside PFD.			
	<u>Bits</u>	<u>Definition</u>		
	00b	~110 ps		
	01b	~220 ps		
	10b	~350 ps		
	11b	~500 ps		
11:8	CG1PLL_CP. Read-write. Reset: 0001b. CG1_PLL charge pump control.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0000b	15 uA	1000b	55 uA
	0001b	10 uA	1001b	50 uA
	0010b	5 uA	1010b	45 uA
	0011b	0 uA	1011b	40 uA
	0100b	35 uA	1100b	75 uA
	0101b	30 uA	1101b	70 uA
	0110b	25 uA	1110b	65 uA
	0111b	20 uA	1111b	60 uA
7:0	CG1PLL_IBIAS. Read-write. Reset: 59h. CG1_PLL current bias control.			
	<u>Bit</u>	<u>Definition</u>		
	[0]	BIAS0		
	[1]	BIAS1		
	[2]	CPTUNE0		
	[3]	CPTUNE1		
	[4]	AMPTUNE0 (SPARE)		
	[5]	AMPTUNE1 (SPARE)		
	[6]	HALFGM		
	[7]	SPARE		

MISCx24 ClkDrvStr1

Bits	Description										
31:20	CG2PLL_FBDIV . Read-write. Reset: 48. Integer part setting of the CG2_PLL feedback divider value. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>Divide by 2</td></tr> <tr> <td>1</td><td>Divide by 2</td></tr> <tr> <td>FFFh-2h</td><td>Divide by <CG2PLL_FBDIV></td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	Divide by 2	1	Divide by 2	FFFh-2h	Divide by <CG2PLL_FBDIV>		
<u>Bits</u>	<u>Definition</u>										
0	Divide by 2										
1	Divide by 2										
FFFh-2h	Divide by <CG2PLL_FBDIV>										
19:18	SLT_GFX_ClockBufferDrivingStrengthControl . Read-write. Reset: 10b. Drive strength control for SLT_GFX differential clock buffers. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>12 mA</td></tr> <tr> <td>01b</td><td>13 mA</td></tr> <tr> <td>10b</td><td>14 mA</td></tr> <tr> <td>11b</td><td>15 mA</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	12 mA	01b	13 mA	10b	14 mA	11b	15 mA
<u>Bits</u>	<u>Definition</u>										
00b	12 mA										
01b	13 mA										
10b	14 mA										
11b	15 mA										
17	CG2PLL_BYPASS_CAL . Read-write. Reset: 0. CG2_PLL Calibration bypass enable. 0=Always do VCO calibration after a reset. 1=Bypass VCO calibration after a reset.										
16	CG2PLL_CAL_BYPASS_REFDIV_EN . Read-write. Reset: 0. CG2_PLL Calibration reference divider bypass enable. 0=Reference divider set by MISCx28 [CG2PLL_CAL_REFDIV] during calibration. 1=Bypass reference divider during calibration.										
15:12	CG2PLL_VREG_BIAS . Read-write. Reset: 0. CG2_PLL Voltage regulator current bias control (Spare).										
11:10	CG2PLL_VREG_CNTL . Read-write. Reset: 0. CG2_PLL Voltage regulator voltage control (Spare).										
9	CG2PLL_VREG_VREF_SEL . Read-write. Reset: 0. CG2_PLL Select Voltage regulator reference (Spare). 0=Bandgap. 1=Resistor Divider.										
8	CG2PLL_PLLCORE_PWDN_EN . Read-write. Reset: 0. CG2_PLL Control for power-down PLL's analog core (including PFD/CP, OTA, VCO, REFGENS, LF and all Diff output drivers). It is only used for external clock-chip mode to bypass XTALIN 25 MHz to SATA differentially when CG2_PLL is required to be off. 0=Disable. 1=Enable.										
7:6	GppClk3_ClockBufferDrivingStrengthControl . Read-write. Reset: 10b. Drive strength control for GPP_CLK3 differential clock buffers. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>12 mA</td></tr> <tr> <td>01b</td><td>13 mA</td></tr> <tr> <td>10b</td><td>14 mA</td></tr> <tr> <td>11b</td><td>15 mA</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	12 mA	01b	13 mA	10b	14 mA	11b	15 mA
<u>Bits</u>	<u>Definition</u>										
00b	12 mA										
01b	13 mA										
10b	14 mA										
11b	15 mA										
5:4	GppClk2_ClockBufferDrivingStrengthControl . Read-write. Reset: 10b. Drive strength control for GPP_CLK2 differential clock buffers. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>12 mA</td></tr> <tr> <td>01b</td><td>13 mA</td></tr> <tr> <td>10b</td><td>14 mA</td></tr> <tr> <td>11b</td><td>15 mA</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	12 mA	01b	13 mA	10b	14 mA	11b	15 mA
<u>Bits</u>	<u>Definition</u>										
00b	12 mA										
01b	13 mA										
10b	14 mA										
11b	15 mA										

3:2	GppClk1_ClockBufferDrivingStrengthControl. Read-write. Reset: 10b. Drive strength control for GPP_CLK1 differential clock buffers. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>12 mA</td></tr> <tr> <td>01b</td><td>13 mA</td></tr> <tr> <td>10b</td><td>14 mA</td></tr> <tr> <td>11b</td><td>15 mA</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	12 mA	01b	13 mA	10b	14 mA	11b	15 mA
<u>Bits</u>	<u>Definition</u>										
00b	12 mA										
01b	13 mA										
10b	14 mA										
11b	15 mA										
1:0	GppClk0_ClockBufferDrivingStrengthControl. Read-write. Reset: 10b. Drive strength control for GPP_CLK0 differential clock buffers. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>12 mA</td></tr> <tr> <td>01b</td><td>13 mA</td></tr> <tr> <td>10b</td><td>14 mA</td></tr> <tr> <td>11b</td><td>15 mA</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	12 mA	01b	13 mA	10b	14 mA	11b	15 mA
<u>Bits</u>	<u>Definition</u>										
00b	12 mA										
01b	13 mA										
10b	14 mA										
11b	15 mA										

MISCx28 ClkDrvStr2

Bits	Description										
31:28	CG2PLL_FBDIV_FRACTION. Read-write. Reset: 0. Fractional part setting of CG2_PLL Feed-back divider value. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>0</td></tr> <tr> <td>9-1</td><td><CG2PLL_FBDIV_FRACTION*0.1></td></tr> <tr> <td>15-10</td><td>0</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	0	9-1	<CG2PLL_FBDIV_FRACTION*0.1>	15-10	0		
<u>Bits</u>	<u>Definition</u>										
0	0										
9-1	<CG2PLL_FBDIV_FRACTION*0.1>										
15-10	0										
27:24	Reserved.										
23:22	CG2PLL_FBDIV_FRACTION_CTL. Read-write. Reset: 1. CG2_PLL Slip Req/Ack handshaking control. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Slip_req/Slip_ack handshake (8 VCO clock cycles per slip)</td></tr> <tr> <td>01b</td><td>Slip once every clock cycle (ignore slip_ack)</td></tr> <tr> <td>10b</td><td>Slip once every 2 clock cycles (ignore slip_ack)</td></tr> <tr> <td>11b</td><td>Slip once every 4 clock cycles (ignore slip_ack)</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Slip_req/Slip_ack handshake (8 VCO clock cycles per slip)	01b	Slip once every clock cycle (ignore slip_ack)	10b	Slip once every 2 clock cycles (ignore slip_ack)	11b	Slip once every 4 clock cycles (ignore slip_ack)
<u>Bits</u>	<u>Definition</u>										
00b	Slip_req/Slip_ack handshake (8 VCO clock cycles per slip)										
01b	Slip once every clock cycle (ignore slip_ack)										
10b	Slip once every 2 clock cycles (ignore slip_ack)										
11b	Slip once every 4 clock cycles (ignore slip_ack)										
21:19	OSCOUT2_CLK_SEL. Read-write. Reset: 0. Defines auxiliary output clock frequency on USB-CLK/OSCOUT2 pin. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>000b</td><td>48 MHz, non-spread</td></tr> <tr> <td>001b</td><td>25 MHz, spread</td></tr> <tr> <td>111b-010b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	000b	48 MHz, non-spread	001b	25 MHz, spread	111b-010b	Reserved		
<u>Bits</u>	<u>Definition</u>										
000b	48 MHz, non-spread										
001b	25 MHz, spread										
111b-010b	Reserved										
18:16	OSCOUT1_CLK_SEL. Read-write. Reset: 0. Defines auxiliary output clock frequency on OSCOUT1 pin. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>000b</td><td>48 MHz, non-spread</td></tr> <tr> <td>001b</td><td>25 MHz, spread</td></tr> <tr> <td>111b-010b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	000b	48 MHz, non-spread	001b	25 MHz, spread	111b-010b	Reserved		
<u>Bits</u>	<u>Definition</u>										
000b	48 MHz, non-spread										
001b	25 MHz, spread										
111b-010b	Reserved										

15:14	CG2PLL_LOCK_FREQ_SEL. Read-write. Reset: 0. CG2_PLL VCO centre frequency selection for calibration. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>set VCO centre at 1200 MHz</td></tr> <tr> <td>01b</td><td>set VCO centre at 1000 MHz</td></tr> <tr> <td>10b</td><td>set VCO centre at 800 MHz</td></tr> <tr> <td>11b</td><td>Forbidden</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	set VCO centre at 1200 MHz	01b	set VCO centre at 1000 MHz	10b	set VCO centre at 800 MHz	11b	Forbidden
<u>Bits</u>	<u>Definition</u>										
00b	set VCO centre at 1200 MHz										
01b	set VCO centre at 1000 MHz										
10b	set VCO centre at 800 MHz										
11b	Forbidden										
13:4	CG2PLL_REF_DIV. Read-write. Reset: 1. CG2_PLL Reference divider control. It is only used after calibration is done. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>Bypass</td></tr> <tr> <td>1</td><td>Bypass</td></tr> <tr> <td>3Fh-2h</td><td>Divide by <CG2PLL_REF_DIV></td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	Bypass	1	Bypass	3Fh-2h	Divide by <CG2PLL_REF_DIV>		
<u>Bits</u>	<u>Definition</u>										
0	Bypass										
1	Bypass										
3Fh-2h	Divide by <CG2PLL_REF_DIV>										
3:0	CG2PLL_CAL_REFDIV. Read-write. Reset: 2. CG2_PLL Calibration reference divider control. It is only used when MISCx24 [CG2PLL_CAL_BYPASS_REFDIV] == 0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>Invalid</td></tr> <tr> <td>1</td><td>Invalid</td></tr> <tr> <td>Fh-2h</td><td>Divide by <CG2PLL_CAL_REFDIV></td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	Invalid	1	Invalid	Fh-2h	Divide by <CG2PLL_CAL_REFDIV>		
<u>Bits</u>	<u>Definition</u>										
0	Invalid										
1	Invalid										
Fh-2h	Divide by <CG2PLL_CAL_REFDIV>										

MISCx2C ClkGatedCntl

Bits	Description																		
31:28	Reserved.																		
27:26	CG2PLL_PFD_PULSE_SEL. Read-write. Reset: 2. CG2_PLL Change reset pulse inside PFD. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>~110 ps</td></tr> <tr> <td>01b</td><td>~220 ps</td></tr> <tr> <td>10b</td><td>~350 ps</td></tr> <tr> <td>11b</td><td>~500 ps</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	~110 ps	01b	~220 ps	10b	~350 ps	11b	~500 ps								
<u>Bits</u>	<u>Definition</u>																		
00b	~110 ps																		
01b	~220 ps																		
10b	~350 ps																		
11b	~500 ps																		
25:18	CG2PLL_IBIAS. Read-write. Reset: 59h. CG2_PLL Current bias control. <table> <tr> <th><u>Bit</u></th><th><u>Definition</u></th></tr> <tr> <td>[0]</td><td>BIAS0</td></tr> <tr> <td>[1]</td><td>BIAS1</td></tr> <tr> <td>[2]</td><td>CPTUNE0</td></tr> <tr> <td>[3]</td><td>CPTUNE1</td></tr> <tr> <td>[4]</td><td>AMPTUNE0 --SPARE</td></tr> <tr> <td>[5]</td><td>AMPTUNE1 --SPARE</td></tr> <tr> <td>[6]</td><td>HALFGM</td></tr> <tr> <td>[7]</td><td>SPARE</td></tr> </table>	<u>Bit</u>	<u>Definition</u>	[0]	BIAS0	[1]	BIAS1	[2]	CPTUNE0	[3]	CPTUNE1	[4]	AMPTUNE0 --SPARE	[5]	AMPTUNE1 --SPARE	[6]	HALFGM	[7]	SPARE
<u>Bit</u>	<u>Definition</u>																		
[0]	BIAS0																		
[1]	BIAS1																		
[2]	CPTUNE0																		
[3]	CPTUNE1																		
[4]	AMPTUNE0 --SPARE																		
[5]	AMPTUNE1 --SPARE																		
[6]	HALFGM																		
[7]	SPARE																		
17	BlinkClkGateOffEn: B-Link Clock Gate Off Enable. Read-write. Cold Reset: 0. BIOS: See 2.17.9.2 . Internal B-Link clock has two clock trees: one is a free running clock and the other is a gated clock. When all controllers agree to stop the gated B-Link clock and this bit is set, clock gating logic will gate off the clock tree from clock root. 0=Disable BLink Clock Gate Off function. 1=Enable BLink Clock Gate Off function.																		

16	AlinkClkGateOffEn: A-Link Clock Gate Off Enable. Read-write. Cold Reset: 0. BIOS: See 2.17.9.2 . Internal A-Link clock has two clock trees: one is a free-running clock and the other is a gated clock. When all controllers agree to stop the gated A-Link clock and this bit is set, clock gating logic will gate off the clock tree from clock root. 0=Disable A-Link Clock Gate-Off function. 1=Enable A-Link Clock Gate-Off function.						
15:8	BlinkClkGateOffThreshold. Read-write. Reset: 0. B-Link Clock Gate Off Threshold. When all controllers agree to stop B-Link clock, clock gating logic will start a timer and deassert BLCIk_Enable when the timer reaches a programmable threshold (BLCIk_Enable is an internal handshake signal indicating whether gated B-Link clock is running or not). <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00h</td><td>Gated clock will stop at 3 falling edge after BLCIk_Enable is deasserted.</td></tr> <tr> <td>FFh-01h</td><td>Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after BLCIk_Enable is deasserted.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00h	Gated clock will stop at 3 falling edge after BLCIk_Enable is deasserted.	FFh-01h	Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after BLCIk_Enable is deasserted.
<u>Bits</u>	<u>Definition</u>						
00h	Gated clock will stop at 3 falling edge after BLCIk_Enable is deasserted.						
FFh-01h	Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after BLCIk_Enable is deasserted.						
7:0	AlinkClkGateOffThreshold. Read-write. Reset: 0. A-Link Clock Gate Off Threshold. When all controllers agree to stop A-Link clock, clock gating logic will start a timer and deassert ALClk_Enable when the timer reaches a programmable threshold (ALClk_Enable is an internal handshake signal indicating whether gated A-Link clock is running or not). <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00h</td><td>Gated clock will stop at 3 falling edge after ALClk_Enable is deasserted.</td></tr> <tr> <td>FFh-01h</td><td>Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after ALClk_Enable is deasserted.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00h	Gated clock will stop at 3 falling edge after ALClk_Enable is deasserted.	FFh-01h	Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after ALClk_Enable is deasserted.
<u>Bits</u>	<u>Definition</u>						
00h	Gated clock will stop at 3 falling edge after ALClk_Enable is deasserted.						
FFh-01h	Gated clock will stop at <3+AlinkClkGateOffThreshold> falling edge after ALClk_Enable is deasserted.						

MISCx30 CGPLLConfig7

Bits	Description										
31:30	CG2PLL_DS_ORDER. Read-write. Reset: 0. CG2_PLL DS order setting. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>disable</td></tr> <tr> <td>1</td><td>1st order</td></tr> <tr> <td>2</td><td>2nd order</td></tr> <tr> <td>3</td><td>3rd order</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	disable	1	1st order	2	2nd order	3	3rd order
<u>Bits</u>	<u>Definition</u>										
0	disable										
1	1st order										
2	2nd order										
3	3rd order										
29	CG2PLL_SS_MODE. Read-write. Reset: 1. CG2_PLL Spread spectrum mode select. 0=Centre spread. 1=Down spread.										
28	CG2PLL_DS_PRBS_EN. Read-write. Reset: 0. Enable CG2_PLL PRBS17 generator in DS modulator.										
27:21	Reserved.										
20:14	CG2_PDIV_PCIECLK. Read-write. Reset: 12. CG2_PLL 100 MHz clock post divider (PCIe and SATA clock). <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0</td><td>Bypass</td></tr> <tr> <td>1</td><td>Bypass</td></tr> <tr> <td>7Fh-2h</td><td>Divide by <CG2_PDIV_PCIECLK></td></tr> </table>	<u>Bits</u>	<u>Definition</u>	0	Bypass	1	Bypass	7Fh-2h	Divide by <CG2_PDIV_PCIECLK>		
<u>Bits</u>	<u>Definition</u>										
0	Bypass										
1	Bypass										
7Fh-2h	Divide by <CG2_PDIV_PCIECLK>										

13:7	CG2_PDIV_USB2CLK. Read-write. Reset: 25. CG2_PLL USB2 clock post divider (USB 2 48 MHz clock).
<u>Bits</u>	<u>Definition</u>
0	Bypass
1	Bypass
7Fh-2h	Divide by <CG2_PDIV_USB2CLK>
6:0	CG2_PDIV_CoreCLK. Read-write. Reset: 3. CG2_PLL 400 MHz clock post divider (core clock).
<u>Bits</u>	<u>Definition</u>
0	Bypass
1	Bypass
7Fh-2h	Divide by <CG2_PDIV_CoreCLK>

MISCx34 CGPLLConfig8

Bits	Description
31:16	CG2PLL_SS_STEP_SIZE_DSFRAC. Read-write. Reset: 0. CG2_PLL Spread spectrum step size DS control.
15:0	CG2PLL_DS_FRAC. Read-write. Reset: 0. CG2_PLL DS fractional setting.

MISCx38 CGPLLConfig9

Bits	Description
31	Reserved.
30	CG2PLL_CLKOUT3A_PDIVSEL. Read-write. Reset: 1. CG2_PLL CLKOUT3A select between RefClk (input of reference divider) and post divider 3. 0=Input of reference divider. 1=PDIV3 Output.
29	CG2PLL_CLKOUT2_PDIVSEL. Read-write. Reset: 1. CG2_PLL CLKOUT2 select between RefClk (input of reference divider) and post divider 2. 0=Input of reference divider. 1=PDIV2 Output.
28	CG2PLL_CLKOUT1_PDIVSEL. Read-write. Reset: 1. CG2_PLL CLKOUT1 select between RefClk (input of reference divider) and post divider 1. 0=Input of reference divider. 1=PDIV1 Output.
27:24	CG2PLL_SS_AMOUNT_NFRAC_SLIP. Read-write. Reset: 0. CG2_PLL spread spectrum amount fractional setting.
23:16	CG2PLL_SS_AMOUNT_FBDIV. Read-write. Reset: 0. CG2_PLL spread spectrum amount setting.
15:0	CG2PLL_SS_AMOUNT_DSFRAC. Read-write. Reset: 0. CG2_PLL spread spectrum amount DS setting.

MISCx3C CGPLLConfig10

Bits	Description
31	Reserved.
30:27	CG2PLL_CP. Read-write. Reset: 2. CG2_PLL Charge pump control.
<u>Bits</u>	<u>Definition</u>
0000b	0uA
1111b-0001b	<CG2PLL_CP*5uA>

26:18	CG2PLL_LF_MODE. Read-write. Reset: DEh. CG2_PLL Loop filter control. It defines the setting of loop filter R and C values.										
17:13	CG2PLL_CAL_MODE. Read-write. Reset: 5. CG2_PLL VCO calibration mode control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0xxxxb</td><td>VCO mode set to calibrated values</td></tr> <tr> <td>1xxxxb</td><td>VCO mode forced to the value set in CORE_CG2PLL_CAL_MODE[3:0]</td></tr> </table>	Bits	Definition	0xxxxb	VCO mode set to calibrated values	1xxxxb	VCO mode forced to the value set in CORE_CG2PLL_CAL_MODE[3:0]				
Bits	Definition										
0xxxxb	VCO mode set to calibrated values										
1xxxxb	VCO mode forced to the value set in CORE_CG2PLL_CAL_MODE[3:0]										
12:11	CG2PLL_PCALREF. Read-write. Reset: 0. CG2_PLL VCO input2 control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>close loop configuration</td></tr> <tr> <td>1</td><td>1/3 supply voltage</td></tr> <tr> <td>2</td><td>1/2 supply voltage</td></tr> <tr> <td>3</td><td>2/3 supply voltage</td></tr> </table>	Bits	Definition	0	close loop configuration	1	1/3 supply voltage	2	1/2 supply voltage	3	2/3 supply voltage
Bits	Definition										
0	close loop configuration										
1	1/3 supply voltage										
2	1/2 supply voltage										
3	2/3 supply voltage										
10:9	CG2PLL_PVCOREF. Read-write. Reset: 0. CG2_PLL VCO input1 control. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>close loop configuration</td></tr> <tr> <td>1</td><td>1/3 supply voltage</td></tr> <tr> <td>2</td><td>1/2 supply voltage</td></tr> <tr> <td>3</td><td>2/3 supply voltage</td></tr> </table>	Bits	Definition	0	close loop configuration	1	1/3 supply voltage	2	1/2 supply voltage	3	2/3 supply voltage
Bits	Definition										
0	close loop configuration										
1	1/3 supply voltage										
2	1/2 supply voltage										
3	2/3 supply voltage										
8:0	Reserved.										

MISCx40 MiscClkCntl1

Bits	Description
31	CG1_NormalResetSequenceEn. Read-write. Reset: 0. 0=Normal power-up time. 1=Extended power-up time.
30	CG1_Atomic_Update. Read-write; cleared-by-hardware. Reset: 0. 1=Request CG1_PLL to load FBDIV, FBDIV_Fraction, DS_FRAS value into CG1_PLL. The bit is cleared to 0 by hardware after request send to CG1_PLL.
29	Atomic_Update_R_Skip. Read-write. Reset: 0. 1=Hardware initializes CG1 and CG2 atomic update regardless whether CG_PLL is ready from previous update.
28:27	SDCLK_PDIVSEL. Read-write. Reset: 0. SDCLK Post divider selection.
26	CG1PLL_FBDIV_Test. Read-write. Cold reset: 0. 1=Enable loading MISCx10[CG1PLL_FBDIV] value for testing. A warm reset is required for this bit to take effect.
25:23	Reserved.
22	Reserved.
21	Reserved.
20	EnableBlinkClkSlowMode. Read-write. Reset: 0. 1=Enable internal core clock (B-Link clock) running at slower speed (66 MHz) for power saving. This bit only takes effect when MISCx40[1]== 1.
19	DrvStrAuxiliaryClk2. Read-write. Reset: 1. Drive Strength Control for Auxiliary Clock2 (USB-CLK/14M_25M_48M_50M_OSC). 0=4 mA. 1=8 mA.
18	DrvStrAuxiliaryClk1. Read-write. Reset: 1. Drive Strength Control for Auxiliary Clock1 (14M_25M_48M_50M_OSC). 0=4 mA. 1=8 mA.

17	Pwdn25Mxtal. Read-write. Reset: 0. 1=Power off 25M Xtal. 0=Power on 25M Xtal. Setting this bit to 1 can power off 25 MHz Xtal pad when the following conditions are not true. <ul style="list-style-type: none"> • chip in integrated clock mode. • USB 48 MHz clock from CG2_PLL. • SATA use CG2_PLL clock as ref clock source. • 14.318 MHz clock generated from CG2_PLL. • 25 MHz Auxiliary clock selected.
16	Reserved.
15	BlinkClkSlowEnable. Read-write. Reset: 0. 1=Internal B-Link clock runs on 66 MHz. The normal internal B-Link clock runs on 133 MHz. See more detail on MISCx40[20] .
14	OscClkSwitchEn. Read-write. Reset: 0. BIOS: 1. 1=The FCH uses the internal PLL to generate the 14 MHz OscClk.
13	InvertTermResistor. Read-write. Reset: 0. 1=Invert normal RefClk (NB_PCIE_CLK) termination. 0=Normal RefClk termination.
12	Auxiliary_14mClk_Sel. Read-write. Reset: 0. 14 MHz clock selection for Auxiliary clock output. 0=14.285 MHz clock is from CG2_PLL. 1=14.318 MHz clock is from CLK_REQG#/14M_OSC/GPIO65 pin.
11:8	Reserved.
7	OSCOUT2_OutOff. Read-write. Reset: 1. If USB uses internal 48 MHz as clock source, setting this bit to 1 will turn off USBCLK/OSCOUT2 clock output. 0=OSCOUT2 pin output enable. 1=OSCOUT2 pin output disable.
6	UsbClkCfg. Read-write. Reset: 1. Defines whether USB uses the internal or external 48 MHz clock. 0=External 48 MHz. 1=Internal 48 MHz. If USB uses internal 48 MHz as clock source, USBCLK/OSCOUT2 pin can output 24 or 48 MHz clock depending on OSCOUT2_sel setting. If USB uses external 48 MHz clock as clock source, USBCLK/OSCOUT2 pin cannot be used as auxiliary clock output. Output enable of OSCOUT2 pin is controlled by [UsbClkCfg] and [OSCOUT2_OutOff]. When [UsbClkCfg]=1 & [OSCOUT2_OutOff]=0, pin output enable will be on.
5	Reserved.
4	Usb3RefclkSel. Read-write. Reset: 1. BIOS: 0. USB3.0 reference clock source selection in internal clock mode. 0=100 MHz spread clock from internal CG1_PLL. 1=100 MHz non-spread clock from internal CG2_PLL.
3	Reserved.
2	OSCOUT1_ClkOutputEnb. Read-write. Reset: 1. 0=Enable Auxiliary Clock1 and OSCOUT1 clock output. 1=Disable.
1	CoreSpeedMode. Read-write. Reset: 0. Slow down Internal Core Clock (B-Link clock) for power saving. 0=Full speed B-Link clock. 1=Slow speed B-Link clock.
0	Reserved.

MISCx44 MiscClkCntl2

Bits	Description
31:20	Reserved.

19	CG2PLL_CLKOUT3B_CUSTOM_PDIV_EN. Read-write. Reset: 0. CG2_PLL CLKOUT3B (SATA 100 MHz) Post-dividers selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.
18	CG2PLL_CLKOUT3A_CUSTOM_PDIV_EN. Read-write. Reset: 0. CG2_PLL CLKOUT3A (PCIe 100 MHz) Post-dividers selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.
17	CG2PLL_CLKOUT2_CUSTOM_PDIV_EN. Read-write. Reset: 0. CG2_PLL CLKOUT2 (USB2 48 MHz) Post-dividers selection. 0=Use Programmable CMOS PostDIV inside digital block. 1=Use Custom CMOS Post-dividers.
16:10	Reserved.
9	CG1PLL_USB2_CLKOUT_EN. Read-write. Reset: 0. CG1_PLL USB2 28 MHz Clock Output Enable.
8	CG2_PLL_REFCLK_RESET. Read-write. Reset: 0.
7	CG1_PLL_REFCLK_RESET. Read-write. Reset: 0.
6	CG2PLL_ANTIGLITCH_RESET. Read-write. Reset: 0. Anti-glitch reset: Forced to 1 during CG2 PLL reset and set to 0 after reset.
5	CG1PLL_ANTIGLITCH_RESET. Read-write. Reset: 0. Anti-glitch reset: Forced to 1 during CG1 PLL reset and set to 0 after reset.
4	CG2_CAL_REFDIV_Update. Read-write. Reset: 0. 1=Update CG2_CAL_REFDIV from Register MISCx28 [CG2PLL_CAL_REFDIV]. A warm reset is required for this bit to take effect.
3	CG1_CAL_REFDIV_Update. Read-write. Cold reset: 0. 1=Update CG1_CAL_REFDIV from Register MISCx10 [CG1PLL_CAL_REFDIV]. A warm reset is required for this bit to take effect.
2	CG2_FBDIV_Test. Read-write. Cold reset: 0. Enable loading MISCx24 [CG2PLL_FBDIV] value for testing. A warm reset is required for this bit to take effect. 0=Disable. 1=Enable.
1	CG2_FBDIV_LoadEn. Read-write. Reset: 0. 1=Enable loading CG2PLL_FBDIV value from register MISCx24 [CG2PLL_FBDIV].
0	CG1_FBDIV_LoadEn. Read-write. Reset: 0. 1=Enable loading CG1PLL_FBDIV value from register MISCx10 [CG1PLL_FBDIV].

MISCx48 MiscClkCntl3

Bits	Description
31:30	CG2PLL_CLKOUT3B_DIFF_GAIN. Read-write. Reset: 2. Diff CML Driver Strength Control for CG2PLL_CLKGEN_SATA_P/N.
29:28	Cg2PllXtalDpllDiffGain. Read-write. Reset: 10b. Diff CML driver strength control for XTAL_DPLL_REFCLK_P/N (48Mhz).
27:26	CG2PLL_CLKOUT3A_DIFF_PRE_GAIN. Read-write. Reset: 3. Diff CML Pre-Driver Strength Control for CG2PLL_DPLL_REFCLK_P/N and CG2PLL_CLKGEN_SATA_P/N.
25:24	CG2PLL_CLKOUT3A_DIFF_GAIN. Read-write. Reset: 2. Diff CML Driver Strength Control for CG2PLL_CLKGEN_PCIE_USB3_P/N.
23:22	CG2PLL_CLKOUT2_DIFF_GAIN. Read-write. Reset: 2. Diff CML Driver Strength Control for CG2PLL_CLKGEN_USB2_P/N.
21:20	Cg1PllSataUsb2DiffGain. Read-write. Reset: 10b. Diff CML driver strength control for CG1PLL_SATA_USB2_P/N (48Mhz).

19:18	Reserved.
17:16	Reserved.
15:14	CG1PLL_CLKOUT3A_DIFF_GAIN . Read-write. Reset: 2. Diff CML Driver Strength Control for CG1PLL_CLKGEN_PCIE_CPU_USB3_P/N
13:12	CG1PLL_CLKOUT2_DIFF_GAIN . Read-write. Reset: 2. Diff CML Driver Strength Control for CG1PLL_CLKGEN_USB2_P/N.
11:6	CG2PLL_SPARE . Read-write. Reset: 0. CG2_PLL general spare pins.
5	Reserved.
4:3	Cg1XtalCmlPreDiffGain . Read-write. Reset: 10b. CG1_PLL CML driver strength selection for both SATA2/USB and DPLL_REFCLK output drivers.
2:0	CG2PLL_DIG_SPARE . Read-write. Reset: 0. CG2_PLL spare pins to digital block.

MISCx4C MiscClkCntl4

Bits	Description
31	LowPowerDisplay400MClkEnB . Read-write. Reset: 0. 0=Enable low power display 400Mhz clock output. 1=Disable.
30	LowPowerDisplay300MClkEnB . Read-write. Reset: 0. 0=Enable low power display 300Mhz clock output. 1=Disable.
29	Reserved.
28:0	Reserved.

MISCx60 IdleCntrl

Bits	Description
31:24	IdleCount . Read-write. Reset: X. This returns the idle count from the latest monitored period.
23:16	Reserved.
15:8	IdleThreshold . Read-write. Reset: 80h. This defines the idle-ness threshold when the dynamic clock logic down shifts the clock frequency. Each unit represents 1/256 of the interval.
7:6	Reserved.
5:0	Reserved.

MISCx68 Memory Power Saving Control

Bits	Description
31:30	Reserved.
29:19	Reserved.
18:17	Reserved.
16	Reserved.
15:5	Reserved.
4	Reserved.

3	Reserved.
2	ABypassMemDsd. Read-write. Reset: 1. BIOS: See 2.17.11.2. AB memory BypassMemdsd control. 0=Enable memory deep sleep and shutdown features. 1=Disable memory deep sleep and shutdown.
1:0	Reserved.

MISCx6C MiscControl

Bits	Description
31	PostCodeWidthSel. Read-write. Reset: 0. 1=Reading MISCx78 [PostCode] returns a 8-bit Post Code. 0=Reading MISCx78 [PostCode] returns a 32-bit Post Code.
30:0	Reserved.

MISCx70 OscFreqCounter

Bits	Description
31	CountEnable. Read-write. Reset: 0b. 1=Enable the internal counter to count the number of OSC clocks. When software is not using this function, it should always set it back to 0 to conserve power.
30	CountIsValid. Read-only. Reset: 0b. 1=OscCountPerSec is valid. Software should always wait for this bit to be set before it reads OscCountPerSec.
29:28	Reserved.
27:0	OscCountPerSec. Read-write. Reset: 0000000h. Number of OSC clocks per 1 second. Whenever [CountEnable] is set, an internal counter will start counting the number of OSC clocks per second and record the count value here.

MISCx74 HpetClkPeriod

Bits	Description
31:0	HpetClkPeriod. Read-write. Reset: 0429B17Eh. The register controls the value of HPETx004[CounterClkPeriod] register in HPET MMIO register space.

MISCx78 PostCode

Bits	Description
31:0	PostCode[31:0]. Read-only. Reset: 0. BIOS 32 bit writes to IO080 [PostCode 0] go to this internal 32-bit PostCode Register. Reads from IO080 [PostCode 0] return PostCode[7:0].

MISCx80 StrapStatus

Bits	Description
31:19	Reserved.

18	BifGen2ComplianceStrap. Read-only. Reset: 0. BIF gen 2 compliance strap.
17	ClkGenStrap. Read-only. Reset: X. BIOS: See 2.17.9. 1==Internal clocking mode; Use 48MHz crystal clock as the reference clock. 0=External clocking mode; Use 100MHz differential spread clock as the reference clock.
16	BootFailTmrEnStrap. Read-only. Reset: X. Enable Watchdog function.
15	PciRomBootStrap. Read-only. Reset: 1. PCI ROM Boot.
14:13	Reserved.
12	CPUClkSelStrap. Read-only. Reset: 0.
11	ShortResetStrap. Read-only. Reset: 0. Generate short reset
10	PciPllBypStrap. Read-only. Reset: 0. Bypass PCI PLL (used in functional test at tester).
9	SDPllBypStrap. Read-only. Reset: 0.
8	Reserved.
7	I2CRomStrap. Read-only. Reset: 0. Getting UMI core strap from I2C ROM or using default value.
6	Reserved.
5	Reserved.
4:3	Reserved.
2	EcEnableStrap. Read-only. Reset: 0. BIOS: See 2.17.8. 1=IMC is enabled.
1	UseLpcRomStrap. Read-only. Reset: X.
0	SpiPadVoltSelStrap. Read-write. Reset: 0. BIOS: See 2.17.8. 1=Configure SPI pads to 1.8v. 0=SPI pads are not 1.8v.

MISCx90 AutoTransaction/Allow EC

Bits	Description										
31:10	Reserved.										
9	DisableAuto. Read; write-1-only. Reset: 0. 1=The entire Auto Transaction logic is disabled. Once this bit is set, it cannot be cleared except by system reset.										
8	AllowECToAutoTransactEn. Read-write. Reset: 0. Only BIOS can change this bit. 0= IMC cannot write to any of registers MISCx90/MISCx94/MISCx98/MISCx9C in the Auto Transaction Generation logic. 1=IMC can change any of these registers.										
7:4	TransactionType. Read-write. Reset: 0. PCI Command type used for this auto transaction. See PCI specification for PCI command types.										
3:2	ByteCount. Read-write. Reset: 0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>1 byte</td></tr> <tr> <td>01b</td><td>2 bytes</td></tr> <tr> <td>10b</td><td>4 bytes</td></tr> <tr> <td>11b</td><td>4 bytes</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	1 byte	01b	2 bytes	10b	4 bytes	11b	4 bytes
<u>Bits</u>	<u>Definition</u>										
00b	1 byte										
01b	2 bytes										
10b	4 bytes										
11b	4 bytes										
1	DualAddr. Read-write. Reset: 0. 0=Use single address cycle. 1=Use dual address cycle.										
0	AutoExecute. Read-write; cleared-by-hardware. Reset: 0. Writing 1 to this bit causes the HW to execute the transaction defined by bit[7:1]. Once it is written, this bit stays as 1 until the transaction is completed, in which case it will return to 0.										

MISCx94 AutoAddrLow

Bits	Description
31:0	AutoAddrLow . Read-write. Reset: 0. Low address to be used by the MISCx90[AutoExecute] operation.

MISCx98 AutoAddrHigh

Bits	Description
31:0	AutoAddrHigh . Read-write. Reset: 0. High address to be used by the MISCx90[AutoExecute] operation. This register is only applicable when MISCx90[DualAddr] == 1.

MISCx9C AutoData

Bits	Description
31:0	AutoData . Read-write. Reset: 0. If MISCx90[TransactionType] is read, this register will return the read data. If the MISCx90[TransactionType] is a write command, this register will contain the write data. Note byte is aligned accordingly.

MISCxC0 CPU Pstate0

Bits	Description																		
31:15	Reserved.																		
14:12	Core3Pstate . Read-only. Reset: 0. See: Core0Pstate.																		
11	Reserved.																		
10:8	Core2Pstate . Read-only. Reset: 0. See: Core0Pstate.																		
7	Reserved.																		
6:4	Core1Pstate . Read-only. Reset: 0. See: Core0Pstate.																		
3	Reserved.																		
2:0	Core0Pstate . Read-only. Reset: 0. FCH will monitor the P state of each CPU core. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>000b</td><td>P0</td></tr> <tr> <td>001b</td><td>P1</td></tr> <tr> <td>010b</td><td>P2</td></tr> <tr> <td>011b</td><td>P3</td></tr> <tr> <td>100b</td><td>P4</td></tr> <tr> <td>101b</td><td>P5</td></tr> <tr> <td>110b</td><td>P6</td></tr> <tr> <td>111b</td><td>P7</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	000b	P0	001b	P1	010b	P2	011b	P3	100b	P4	101b	P5	110b	P6	111b	P7
<u>Bits</u>	<u>Definition</u>																		
000b	P0																		
001b	P1																		
010b	P2																		
011b	P3																		
100b	P4																		
101b	P5																		
110b	P6																		
111b	P7																		

MISCC4 CPU Pstate1

Bits	Description
31:0	Reserved.

MISCD0 CPU Cstate0

Bits	Description																		
31:15	Reserved.																		
14:12	Core3Cstate . Read-only. Reset: 0. See: Core0Cstate.																		
11	Reserved.																		
10:8	Core2Cstate . Read-only. Reset: 0. See: Core0Cstate.																		
7	Reserved.																		
6:4	Core1Cstate . Read-only. Reset: 0. See: Core0Cstate.																		
3	Reserved.																		
2:0	Core0Cstate . Read-only. Reset: 0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>000b</td><td>C0</td></tr> <tr> <td>001b</td><td>C1</td></tr> <tr> <td>010b</td><td>C2</td></tr> <tr> <td>011b</td><td>C3</td></tr> <tr> <td>100b</td><td>C4</td></tr> <tr> <td>101b</td><td>C5</td></tr> <tr> <td>110b</td><td>C6</td></tr> <tr> <td>111b</td><td>C7</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	000b	C0	001b	C1	010b	C2	011b	C3	100b	C4	101b	C5	110b	C6	111b	C7
<u>Bits</u>	<u>Definition</u>																		
000b	C0																		
001b	C1																		
010b	C2																		
011b	C3																		
100b	C4																		
101b	C5																		
110b	C6																		
111b	C7																		

MISCD4 CPU Cstate1

Bits	Description
31:0	Reserved.

MISCF0 SataPortSts

Bits	Description										
31:26	Reserved.										
25:24	SataPortSel . Read-write. Reset: 0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Select “led” for Port 0 to 1</td></tr> <tr> <td>01b</td><td>Select “det” for Port 0 to 1</td></tr> <tr> <td>10b</td><td>Select “err” for Port 0 to 1</td></tr> <tr> <td>11b</td><td>Select “led” for Port 0 to 1</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Select “led” for Port 0 to 1	01b	Select “det” for Port 0 to 1	10b	Select “err” for Port 0 to 1	11b	Select “led” for Port 0 to 1
<u>Bits</u>	<u>Definition</u>										
00b	Select “led” for Port 0 to 1										
01b	Select “det” for Port 0 to 1										
10b	Select “err” for Port 0 to 1										
11b	Select “led” for Port 0 to 1										
23:2	Reserved.										

1	Port1Sts. Read-write. Reset: X. The selected status of Port 1. This status bit indicates the internal status of SATA port 1.
0	Port0Sts. Read-write. Reset: X. The selected status of Port 0. This status bit indicates the internal status of SATA port 0.

MISCF4 ClkCntrlSts

Bits	Description
31:0	Reserved.

3.26.12 GPIO Pin control registers

The GPIO pins are controlled by a combination of device enables and by their specific GPIO and IOMUXregister pair.

3.26.12.1 GPIO Registers

GPIO registers are accessed through memory-mapped ACPIMMIO region. The offset is relative to FED8_0000h+1500h. GPIO bank 0 registers range from FED8_0000h+1500h to FED8_0000h+15FFh. GPIO Bank 1 registers range from FED8_0000h+1600h to FED8_0000h+16FFh. GPIO Bank 2 registers range from FED8_0000h+1700h to FED8_0000h+17FFh.

GPIOx[0F8:000:step4] GPIO Bank 0 Control Register

Each GPIO pin is controlled by 4 bytes. These registers control GPIO bank 0 pins: GPIO62-GPIO00.

Table 262: Function name for [GPIOx\[0F8:000:step4\]](#)

Register	Reset	Function	Register	Reset	Function
GPIOx000	0000_0000h	PWR_BTN_L_AGPI00	GPIOx080	0000_0000h	SPI_HOLD_L_EGPIO32
GPIOx004	0014_0000h	SYS_RESET_L_AGPI01	GPIOx084	0004_0000h	SPI_CLK_EGPIO33
GPIOx008	0014_0000h	WAKE_L_AGPI02	GPIOx088	0004_0000h	SPI_CS1_L_EGPIO34
GPIOx00C	0014_0000h	GEVENT2_L_AGPI03	GPIOx08C	0004_0000h	SPI_CS2_L_EGPIO35
GPIOx010	0004_0000h	GEVENT4_L_AGPI04	GPIOx090	0004_0000h	SPI_DI_EGPIO36
GPIOx014	0004_0000h	GEVENT7_L_AGPI05	GPIOx094	0004_0000h	SPI_DO_EGPIO37
GPIOx018	0014_0000h	GEVENT10_L_AGPI06	GPIOx098	0004_0000h	SPI_WP_L_EGPIO38
GPIOx01C	0014_0000h	GEVENT11_L_AGPI07	GPIOx09C	0000_0000h	Reserved
GPIOx020	0014_0000h	LPC_SMI_L_AGPI08	GPIOx0A0	0000_0000h	Reserved
GPIOx024	0014_0000h	GEVENT22_L_AGPI09	GPIOx0A4	0000_0000h	Reserved
GPIOx028	0014_0000h	GPIO174_AGPI010	GPIOx0A8	0000_0000h	Reserved

Table 262: Function name for GPIOx[0F8:000:step4]

GPIOx02C	0014_0000h	BLINK_AGPI011	GPIOx0AC	0000_0000h	Reserved
GPIOx030	0014_0000h	IR_LED_L_A GPIO12	GPIOx0B0	0000_0000h	Reserved
GPIOx034	0014_0000h	IR_TX0_AGPI013	GPIOx0B4	0000_0000h	Reserved
GPIOx038	0014_0000h	IR_TX1_AGPI014	GPIOx0B8	0000_0000h	Int_FakeSts0
GPIOx03C	0014_0000h	IR_RX1_AGPI015	GPIOx0BC	0000_0000h	Int_ImcSci
GPIOx040	0004_0000h	USB_OC0_L_AGPI016	GPIOx0C0	0000_0000h	Int_CIR_Wake
GPIOx044	0014_0000h	USB_OC1_L_AGPI017	GPIOx0C4	0000_0000h	Int_ASFSlaveIntr
GPIOx048	0014_0000h	USB_OC2_L_AGPI018	GPIOx0C8	0000_0000h	Int_Smbus0Intr
GPIOx04C	0004_0000h	SCL1_EGPI019	GPIOx0CC	0000_0000h	Int_WakeFromLLB
GPIOx050	0004_0000h	SDA1_EGPI020	GPIOx0D0	0000_0000h	Int_AcDcTimerEvent
GPIOx054	0014_0000h	LPC_PD_L_A GPIO21	GPIOx0D4	0000_0000h	Int_ALTHPET_TimerSts
GPIOx058	0014_0000h	LPC_PME_L_AGPI022	GPIOx0D8	0000_0000h	Int_UsbDev18fun0Wakeup
GPIOx05C	0014_0000h	AC_PRESENSE_AGPI023	GPIOx0DC	0000_0000h	Int_UsbDev19fun0Wakeup
GPIOx060	0014_0000h	USB_OC3_L_AGPI024	GPIOx0E0	0000_0000h	Int_UsbDev20fun0Wakeup
GPIOx064	0004_0000h	GEVENT17_L_AGPI025	GPIOx0E4	0000_0000h	GPIOx0E4
GPIOx068	0024_0000h	AZ_SDIN0_E GPIO26	GPIOx0E8	0000_0000h	Int_xhcDev16Fun0Wakeup
GPIOx06C	0024_0000h	AZ_SDIN1_E GPIO27	GPIOx0EC	0000_0000h	Int_xhcDev16Fun1Wakeup
GPIOx070	0024_0000h	AZ_SDIN2_E GPIO28	GPIOx0F0	0000_0000h	Int_iAzPme
GPIOx074	0024_0000h	AZ_SDIN3_E GPIO29	GPIOx0F4	0000_0000h	x0F4_Reserved
GPIOx078	0004_0000h	LPCCLK0_EGPI030	GPIOx0F8	0000_0000h	x0F8_Reserved
GPIOx07C	0004_0000h	LPCCLK1_EGPI031			

Internal-GPIO register format. Table 262 lists Internal GPIO function as Int_XXX (i.e. Int_iAzPme).

Bits	Description
31:30	Reserved.
29	WakeSts. Read; write-1-to-clear. 0=The pin didn't generate wake event. 1=The pin is a wake source.
28	InterruptSts. Read; write-1-to-clear. 0=The pin didn't generate interrupt. 1=The pin is a interrupt source.

27:26	Reserved.
25	SwCntrlEn. Read-write. 0=Disable software controlled GPIO in. 1=Enable software controlled GPIO in.
24	SwCntrlIn. Read-write. When SwCntrlEn is 1, this bit can be used by software to control the GPIO input to the GPIO controller.
23:17	Reserved.
16	PinSts. Read-only; updated-by-hardware. 0=The pin is low. 1=The pin is high.
15:13	WakeCntrl. Read-only. WakeCntrl[0] enable wake in S0i3 state, WakeCntrl[1] enable wake in S3 state, WakeCntrl[2] enable wake in S4/S5 state.
12:11	InterruptEnable. Read-only. InterruptEnable[0] enables interrupt status; InterruptEnable[1] enables interrupt delivery.
10:9	ActiveLevel. Read-only. 00=Active high; 01= Active Low; 10=Active on both of edges if LevelTrig is set to 0; 11=reserved.
8	LevelTrig. Read-only. 0=Edge trigger; 1=Level trigger;.
7:0	Reserved

Table 263: Debounce Timer Definition

DebounceTmrLarge	DebounceTmrOutUnit	Timer Unit	Max Debounce Time
0	0	61 usec (2 RtcClk)	976 usec
0	1	244 usec (8 RtcClk)	3.9 msec
1	0	15.6 msec (512 RtcClk)	250 msec
1	1	62.5 msec (2048 RtcClk)	1 sec

External-GPIO register format. See [Table 262](#) for GPIO function.

Bits	Description												
31:30	Reserved.												
29	WakeSts. Read; write-1-to-clear. 0=The pin didn't generate wake event. 1=The pin is a wake source.												
28	InterruptSts. Read; write-1-to-clear. 0=The pin didn't generate interrupt. 1=The pin is a interrupt source.												
27:26	Reserved.												
25:24	Reserved.												
23	OutputEnable. Read-write. 0=Output is disabled on the pin. 1=Output is enabled on the pin.												
22	OutputValue. Read-write. 0=low. 1=high.												
21	PullDownEnable. Read-write. 0=Pull-down is disabled on the pin. 1=Pull-down is enabled on the pin.												
20	PullUpEnable. Read-write. 0=Pull-up is disabled on the pin. 1=Pull-up is enabled on the pin.												
19	PullUpSel. Read-write. 0=4 K pull-up is selected. 1=8 K pull-up is selected.												
18:17	DrvStrengthSel. Read-write. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>4 mA</td><td>10b</td><td>12 mA</td></tr><tr><td>01b</td><td>8 mA</td><td>11b</td><td>16 mA</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	4 mA	10b	12 mA	01b	8 mA	11b	16 mA
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	4 mA	10b	12 mA										
01b	8 mA	11b	16 mA										

16	PinSts. Read-only; updated-by-hardware. 0=The pin is low. 1=The pin is high. This bit is not affected by the debounce logic.															
15:13	WakeCntrl[2:0]. Read-write. <table><tr><th>Bit</th><th>Definition</th></tr><tr><td>[0]</td><td>1=Enable wake in S0I3 state</td></tr><tr><td>[1]</td><td>1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)</td></tr><tr><td>[2]</td><td>1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)</td></tr></table>				Bit	Definition	[0]	1=Enable wake in S0I3 state	[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)	[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)				
Bit	Definition															
[0]	1=Enable wake in S0I3 state															
[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)															
[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)															
12:11	InterruptEnable[1:0]. Read-write. <table><tr><th>Bit</th><th>Definition</th></tr><tr><td>[0]</td><td>1=Enable interrupt status</td></tr><tr><td>[1]</td><td>1=Enable interrupt delivery</td></tr></table>				Bit	Definition	[0]	1=Enable interrupt status	[1]	1=Enable interrupt delivery						
Bit	Definition															
[0]	1=Enable interrupt status															
[1]	1=Enable interrupt delivery															
10:9	ActiveLevel. Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>Active high</td><td>10b</td><td>Active on both of edges if LevelTrig=0</td></tr><tr><td>01b</td><td>Active Low</td><td>11b</td><td>Reserved</td></tr></table>				Bits	Definition	Bits	Definition	00b	Active high	10b	Active on both of edges if LevelTrig=0	01b	Active Low	11b	Reserved
Bits	Definition	Bits	Definition													
00b	Active high	10b	Active on both of edges if LevelTrig=0													
01b	Active Low	11b	Reserved													
8	LevelTrig. Read-write. 0=Edge trigger. 1=Level trigger.															
7	Reserved.															
6:5	DebounceCntrl. Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>No debounce</td><td>10b</td><td>Preserve high glitch</td></tr><tr><td>01b</td><td>Preserve low glitch</td><td>11b</td><td>Remove glitch</td></tr></table>				Bits	Definition	Bits	Definition	00b	No debounce	10b	Preserve high glitch	01b	Preserve low glitch	11b	Remove glitch
Bits	Definition	Bits	Definition													
00b	No debounce	10b	Preserve high glitch													
01b	Preserve low glitch	11b	Remove glitch													
4	DebounceTmrOutUnit. Read-write. 0=30.5 us (one RtcClk period). 1=122 us (four RtcClk periods).															
3:0	DebounceTmrOut. Read-write. Specifies the debounce timer out number. 0=Debounceing logic is disabled.															

GPIOxFC GPIO_Wake_Inter_Master Switch

Bits	Description
31	GpioWakeEn. Read-write. Reset: 1. 0=All GPIO wake are blocked.
30	GpioInterruptEn. Read-write. Reset: 1. 0=All GPIO interrupts are blocked.
29	EOI. Read-write; cleared-by-hardware. Reset: 1. This bit is set to 1 by software when it is allowed to send GPIO interrupt. Hardware clears this bit when interrupt occurs. When this bit is 0, the GPIO interrupt is blocked. This SW/HW handshake mechanism is the same with EOS of SMI.
28	MaskStsEn. Read-write. Reset: 1. 1=Enable hardware to block all wake/interrupt status generation when software writes to any debounce registers. The length of blocking depends on mask_sts_length[3:0].
27:24	MaskStsLength[3:0]. Read-write. Reset: 1111b. See MaskStsEn. The length of blocking={MaskStsLength[3:0], 14'h3FFF}.
23	large_gpio0_dbnc. Read-write. Reset: 1. GPIO0 debounce timer unit only. When DebounceTmrOutUnit=0, Debounce timer unit=61 us (one RtcClk period). When DebounceTmrOutUnit=1 and large_gpio0_dbnc=0, Debounce timer unit=244 us (four RtcClk periods). When DebounceTmrOutUnit=1 and large_gpio0_dbnc=1, Debounce timer unit=15.6 ms (256 RtcClk periods).

22:16	Reserved.
15	EnWinBlueBtn. Read-write. 0=GPIO0 detect debounced power button; Power button override is 4 sec. 1=GPIO0 detect debounced power button in S3/S5/S0I3, and detect "pressed less than 2 sec" and "pressed 2~10 sec" in S0; Power button override is 10 sec.
14:0	Reserved.

GPIOx[1FC:100:step4] GPIO Bank 1 Control Register

Each GPIO pin is controlled by 4 bytes. These registers control GPIO bank 1 pins: GPIO64-GPIO127.

Table 264: Function name for [GPIOx\[1FC:100:step4\]](#)

Register	Reset	Function	Register	Reset	Function
GPIOx100	0000_0000h	GPIO49_AGPI O64	GPIOx180	0010_0000h	SD_CMD_EG PIO96
GPIOx104	0014_0000h	GPIO50_AGPI O65	GPIOx184	0010_0000h	SD_DATA0_E GPIO97
GPIOx108	0014_0000h	GPIO51_AGPI O66	GPIOx188	0010_0000h	SD_DATA1_E GPIO98
GPIOx10C	0004_0000h	GPIO55_AGPI O67	GPIOx18C	0010_0000h	SD_DATA2_E GPIO99
GPIOx110	0024_0000h	GPIO57_AGPI O68	GPIOx190	0010_0000h	SD_DATA3_E GPIO100
GPIOx114	0004_0000h	GPIO58_AGPI O69	GPIOx194	0010_0000h	SD_WP_L_EG PIO101
GPIOx118	0004_0000h	GPIO59_AGPI O70	GPIOx198	0000_0000h	Reserve
GPIOx11C	0012_0000h	GPIO64_AGPI O71	GPIOx19C	0000_0000h	Reserve
GPIOx120	0004_0000h	GPIO68_AGPI O72	GPIOx1A0	0000_0000h	Reserve
GPIOx124	0004_0000h	GPIO69_AGPI O73	GPIOx1A4	0000_0000h	Reserve
GPIOx128	0000_0000h	Reserve	GPIOx1A8	0000_0000h	Reserve
GPIOx12C	0000_0000h	Reserve	GPIOx1AC	0000_0000h	Reserve
GPIOx130	0004_0000h	GPIO70_AGPI O76	GPIOx1B0	0000_0000h	Reserve
GPIOx134	0004_0000h	GPIO71_AGPI O77	GPIOx1B4	0000_0000h	Reserve
GPIOx138	0000_0000h	Reserve	GPIOx1B8	0000_0000h	Reserve
GPIOx13C	0000_0000h	Reserve	GPIOx1BC	0000_0000h	Reserve
GPIOx140	0000_0000h	Reserve	GPIOx1C0	0000_0000h	Reserve
GPIOx144	0000_0000h	Reserve	GPIOx1C4	0000_0000h	SCL0_EGPIO113
GPIOx148	0000_0000h	Reserve	GPIOx1C8	0000_0000h	SDA0_EGPIO114
GPIOx14C	0000_0000h	Reserve(x14C)	GPIOx1CC	0010_0000h	CLK_REQ1_L_EGPIO115
GPIOx150	0010_0000h	FANIN0_EGPI O84	GPIOx1D0	0010_0000h	CLK_REQ2_L_EGPIO116
GPIOx154	0010_0000h	FANOUT0_EG PIO85	GPIOx1D4	0000_0000h	Reserve

Table 264: Function name for GPIOx[1FC:100:step4]

GPIOx158	0000_0000h	Reserve	GPIOx1D8	0000_0000h	Reserve
GPIOx15C	0010_0000h	SERRIQ_EGPI O87	GPIOx1DC	0000_0000h	Reserve
GPIOx160	0010_0000h	LPC_CLKRU N_L_EGPIO88	GPIOx1E0	0000_0000h	Reserve
GPIOx164	0000_0000h	GENINT1_L_ AGPIO89	GPIOx1E4	0000_0000h	Reserve
GPIOx168	0000_0000h	GENINT2_L_ AGPIO90	GPIOx1E8	0000_0000h	Reserve
GPIOx16C	0000_0000h	SPKR_AGPIO 91	GPIOx1EC	0000_0000h	Reserve
GPIOx170	0010_0000h	CLK_REQ0_L_ _AGPIO92	GPIOx1F0	0000_0000h	Reserve
GPIOx174	0000_0000h	SD_LED_EGP IO93	GPIOx1F4	0000_0000h	Reserve
GPIOx178	0010_0000h	SD_CD_EGPI O94	GPIOx1F8	0010_0000h	GA20IN_AGP IO126
GPIOx17C	00010_0000h	SD_CLK_EGP IO95	GPIOx1FC	0000_0000h	Reserve

Bits	Description												
31:30	Reserved.												
29	WakeSts. Read; write-1-to-clear. 0=The pin didn't generate wake event. 1=The pin is a wake source.												
28	InterruptSts. Read; write-1-to-clear. 0=The pin didn't generate interrupt. 1=The pin is a interrupt source.												
27:26	Reserved.												
25:24	Reserved.												
23	OutputEnable. Read-write. 0=Output is disabled on the pin. 1=Output is enabled on the pin.												
22	OutputValue. Read-write. 0=low. 1=high.												
21	PullDownEnable. Read-write. 0=Pull-down is disabled on the pin. 1=Pull-down is enabled on the pin.												
20	PullUpEnable. Read-write. 0=Pull-up is disabled on the pin. 1=Pull-up is enabled on the pin.												
19	PullUpSel. Read-write. 0=4 K pull-up is selected. 1=8 K pull-up is selected.												
18:17	DrvStrengthSel. Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>4 mA</td><td>10b</td><td>12 mA</td></tr><tr><td>01b</td><td>8 mA</td><td>11b</td><td>16 mA</td></tr></table>	Bits	Definition	Bits	Definition	00b	4 mA	10b	12 mA	01b	8 mA	11b	16 mA
Bits	Definition	Bits	Definition										
00b	4 mA	10b	12 mA										
01b	8 mA	11b	16 mA										
16	PinSts. Read-only; updated-by-hardware. 0=The pin is low. 1=The pin is high. This bit is not affected by the debounce logic.												
15:13	WakeCntrl[2:0]. Read-write. <table><tr><th>Bit</th><th>Definition</th></tr><tr><td>[0]</td><td>1=Enable wake in S0I3 state</td></tr><tr><td>[1]</td><td>1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)</td></tr><tr><td>[2]</td><td>1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)</td></tr></table>	Bit	Definition	[0]	1=Enable wake in S0I3 state	[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)	[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)				
Bit	Definition												
[0]	1=Enable wake in S0I3 state												
[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)												
[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)												

12:11	InterruptEnable[1:0] . Read-write. <div> <div><u>Bit</u></div> <div><u>Definition</u></div> </div> <div> <div>[0]</div> <div>1=Enable interrupt status</div> </div> <div> <div>[1]</div> <div>1=Enable interrupt delivery</div> </div>			
10:9	ActiveLevel . Read-write. <div> <div><u>Bits</u></div> <div><u>Definition</u></div> </div> <div> <div>00b</div> <div>Active high</div> </div> <div> <div>01b</div> <div>Active Low</div> </div> <div> <div><u>Bits</u></div> <div><u>Definition</u></div> </div> <div> <div>10b</div> <div>Active on both of edges if LevelTrig=0</div> </div> <div> <div>11b</div> <div>Reserved</div> </div>			
8	LevelTrig . Read-write. 0=Edge trigger. 1=Level trigger.			
7	Reserved.			
6:5	DebounceCntl . Read-write. <div> <div><u>Bits</u></div> <div><u>Definition</u></div> </div> <div> <div>00b</div> <div>No debounce</div> </div> <div> <div>01b</div> <div>Preserve low glitch</div> </div> <div> <div><u>Bits</u></div> <div><u>Definition</u></div> </div> <div> <div>10b</div> <div>Preserve high glitch</div> </div> <div> <div>11b</div> <div>Remove glitch</div> </div>			
4	DebounceTmrOutUnit . Read-write. 0=30.5 us (one RtcClk period). 1=122 us (four RtcClk periods).			
3:0	DebounceTmrOut . Read-write. Specifies the debounce timer out number. 0=Debounceing logic is disabled.			

GPIOx[2DC:200:step4] GPIO Bank 2 Control Register

Each GPIO pin is controlled by 4 bytes. These registers control GPIO Bank 2 pins: GPIO128-GPIO183.

Table 265: Function name for [GPIOx\[2DC:200:step4\]](#)

Register	Reset	Function	Register	Reset	Function
GPIOx200	0000_0000h	Reserve	GPIOx280	0000_0000h	Reserve
GPIOx204	0010_0000h	KBRST_L_AG PIO129	GPIOx284	0000_0000h	Reserve
GPIOx208	0000_0000h	SATA_ACT_A GPIO130	GPIOx288	0000_0000h	Reserve
GPIOx20C	0010_0000h	CLK_REQ3_L _EGPIO131	GPIOx28C	0000_0000h	Reserve
GPIOx210	0010_0000h	CLK_REQG_L _EGPIO132	GPIOx290	0000_0000h	Reserve
GPIOx214	0000_0000h	Reserve	GPIOx294	0000_0000h	Reserve
GPIOx218	0000_0000h	Reserve	GPIOx298	0000_0000h	Reserve
GPIOx21C	0000_0000h	Reserve	GPIOx29C	0000_0000h	Reserve
GPIOx220	0000_0000h	Reserve	GPIOx2A0	0000_0000h	Reserve
GPIOx224	0000_0000h	Reserve	GPIOx2A4	0000_0000h	Reserve
GPIOx228	0000_0000h	Reserve	GPIOx2A8	0000_0000h	Reserve
GPIOx22C	0000_0000h	Reserve	GPIOx2AC	0000_0000h	Reserve
GPIOx230	0000_0000h	Reserve	GPIOx2B0	0000_0000h	Reserve
GPIOx234	0000_0000h	Reserve	GPIOx2B4	0000_0000h	Reserve(xb4)
GPIOx238	0000_0000h	Reserve	GPIOx2B8	0000_0000h	Int_any_SBGp pPme
GPIOx23C	0000_0000h	Reserve	GPIOx2BC	0000_0000h	Int_NBGppPm ePulse
GPIOx240	0000_0000h	Reserve	GPIOx2C0	0000_0000h	Int_AcpiPerfInt r

Table 265: Function name for GPIOx[2DC:200:step4]

GPIOx244	0000_0000h	Reserve	GPIOx2C4	0000_0000h	Int_curFanStat us0
GPIOx248	0000_0000h	Reserve	GPIOx2C8	0000_0000h	Int_FanThermal SCIOut
GPIOx24C	0000_0000h	Reserve	GPIOx2CC	0000_0000h	Int_ASFMaster Intr
GPIOx250	0000_0000h	Reserve	GPIOx2D0	0000_0000h	Int_Ras_event
GPIOx254	0000_0000h	Reserve	GPIOx2D4	0000_0000h	Int_GBL_RLS
GPIOx258	0000_0000h	Reserve	GPIOx2D8	0000_0000h	Int_ShortTimer Event
GPIOx25C	0000_0000h	Reserve	GPIOx2DC	0000_0000h	Int_NBHwAss ertion_r[3]
GPIOx260	0000_0000h	Reserve			
GPIOx264	0000_0000h	Reserve			
GPIOx268	0000_0000h	Reserve			
GPIOx26C	0000_0000h	Reserve			
GPIOx270	0000_0000h	Reserve			
GPIOx274	0000_0000h	Reserve			
GPIOx278	0000_0000h	Reserve			
GPIOx27C	0000_0000h	Reserve			

Bits	Description												
31:30	Reserved.												
29	WakeSts. Read; write-1-to-clear. 0=The pin didn't generate wake event. 1=The pin is a wake source.												
28	InterruptSts. Read; write-1-to-clear. 0=The pin didn't generate interrupt. 1=The pin is a interrupt source.												
27:26	Reserved.												
25:24	Reserved.												
23	OutputEnable. Read-write. 0=Output is disabled on the pin. 1=Output is enabled on the pin.												
22	OutputValue. Read-write. 0=low. 1=high.												
21	PullDownEnable. Read-write. 0=Pull-down is disabled on the pin. 1=Pull-down is enabled on the pin.												
20	PullUpEnable. Read-write. 0=Pull-up is disabled on the pin. 1=Pull-up is enabled on the pin.												
19	PullUpSel. Read-write. 0=4 K pull-up is selected. 1=8 K pull-up is selected.												
18:17	DrvStrengthSel. Read-write. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>4 mA</td><td>10b</td><td>12 mA</td></tr><tr><td>01b</td><td>8 mA</td><td>11b</td><td>16 mA</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	4 mA	10b	12 mA	01b	8 mA	11b	16 mA
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	4 mA	10b	12 mA										
01b	8 mA	11b	16 mA										
16	PinSts. Read-only; updated-by-hardware. 0=The pin is low. 1=The pin is high. This bit is not affected by the debounce logic.												
15:13	WakeCntrl[2:0]. Read-write. <table><tr><th><u>Bit</u></th><th><u>Definition</u></th></tr><tr><td>[0]</td><td>1=Enable wake in S0I3 state</td></tr><tr><td>[1]</td><td>1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)</td></tr><tr><td>[2]</td><td>1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)</td></tr></table>	<u>Bit</u>	<u>Definition</u>	[0]	1=Enable wake in S0I3 state	[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)	[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)				
<u>Bit</u>	<u>Definition</u>												
[0]	1=Enable wake in S0I3 state												
[1]	1=Enable wake in S3 state (SLP_TYP = 3, and !G0_State)												
[2]	1=Enable wake in S4/S5 state (SLP_TYP = 4 or 5, and !G0_State)												

12:11	InterruptEnable[1:0] . Read-write.			
	<u>Bit</u>	<u>Definition</u>		
	[0]	1=Enable interrupt status		
	[1]	1=Enable interrupt delivery		
10:9	ActiveLevel . Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Active high	10b	Active on both of edges if LevelTrig=0
	01b	Active Low	11b	Reserved
8	LevelTrig . Read-write. 0=Edge trigger. 1=Level trigger.			
7	Reserved.			
6:5	DebounceCntl . Read-write.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	No debounce	10b	Preserve high glitch
	01b	Preserve low glitch	11b	Remove glitch
4	DebounceTmrOutUnit . Read-write. 0=30.5 us (one RtcClk period). 1=122 us (four RtcClk periods).			
3:0	DebounceTmrOut . Read-write. Specifies the debounce timer out number. 0=Debounceing logic is disabled.			

GPIOx2F0 GPIO_Wake_Status_Index_0

Bits	Description
31:16	WakeStatusIndex[31:16] . Read-write. Reset: 0. When this bit is 1, it means at least one of the wake status of GPIO N*4 ~ N*4+3 is 1.
15	Reserved.
14:0	WakeStatusIndex[14:0] . Read-write. Reset: 0. For each bit, 1=At least one of the wake status of GPIO N*4 ~ N*4+3 is 1.

GPIOx2F4 GPIO_Wake_Status_Index_1

Bits	Description
31:14	Reserved.
13:0	WakeStatusIndex[13:0] . Read-write. Reset: 0. For each bit, 1=At least one of the wake status of GPIO N*4 ~ N*4+3 is 1.

GPIOx2F8 GPIO_Interrupt_Status_Index_0

Bits	Description
31:16	InterruptStatusIndex[31:16] . Read-write. Reset: 0. When this bit is 1, it means at least one of the interrupt status of GPIO N*4 ~ N*4+3 is 1.
15	Reserved.
14:0	InterruptStatusIndex[14:0] . Read-write. Reset: 0. For each bit, 1=At least one of the interrupt status of GPIO N*4 ~ N*4+3 is 1.

GPIOx2FC GPIO_Interrupt_Status_Index_1

Bits	Description
31:29	Reserved.
28	MaskStsEn. Read-write. Reset: 1. 1=Enable hardware to block all wake/interrupt status generation when software writes to any debounce registers. The length of blocking depends on mask_sts_length[3:0].
27:24	MaskStsLength[3:0]. Read-write. Reset: 1111b. See MaskStsEn. The length of blocking={MaskStsLength[3:0], 14'h3FFF}.
23:14	Reserved.
13:0	InterruptStatusIndex[13:0]. Read-write. Reset: 0. For each bit, 1=At least one of the interrupt status of GPIO N*4 ~ N*4+3 is 1.

3.26.12.2 IOMux Registers

IOMux register space is accessed through the AcpiMmio region. The registers range from FED8_0000h+D00h to FED8_0000h+DFFh. See [PMx04\[Mmio\]](#).

IOMUXx00 PWR_BTN_L_AGPIO0

Bits	Description
7:2	Reserved.
1:0	PWR_BTN_L_AGPIO0. Read-write. Reset: 00b. Multi-function IO pin function select for pin PWR_BTN_L.

IOMUXx01 SYS_RESET_L_AGPIO1

Bits	Description										
7:2	Reserved.										
1:0	SYS_RESET_L_AGPIO1. Read-write. Reset: 00b. Multi-function IO pin function select for pin SYS_RESET_L. <table border="1" data-bbox="272 1444 812 1621"> <thead> <tr> <th>Bits</th><th>Definition</th></tr> </thead> <tbody> <tr> <td>00b</td><td>SYS_RESET_L</td></tr> <tr> <td>01b</td><td>GEVENT19_L/AGPIO1</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </tbody> </table>	Bits	Definition	00b	SYS_RESET_L	01b	GEVENT19_L/AGPIO1	10b	Reserved	11b	Reserved
Bits	Definition										
00b	SYS_RESET_L										
01b	GEVENT19_L/AGPIO1										
10b	Reserved										
11b	Reserved										

IOMUXx02 WAKE_L_AGPIO2

Bits	Description
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7:2	Reserved.										
1:0	WAKE_L_AGPI02. Read-write. Reset: 00b. Multi-function IO pin function select for pin WAKE_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>WAKE_L</td></tr> <tr> <td>01b</td><td>GEVENT8_L/AGPI02</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	WAKE_L	01b	GEVENT8_L/AGPI02	10b	Reserved	11b	Reserved
Bits	Definition										
00b	WAKE_L										
01b	GEVENT8_L/AGPI02										
10b	Reserved										
11b	Reserved										

IOMUXx03 GEVENT2_L_AGPI03

Bits	Description										
7:2	Reserved.										
1:0	GEVENT2_L_AGPI03. Read-write. Reset: 10b. Multi-function IO pin function select for pin GEVENT2_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GEVENT2_L/AGPI03</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	Reserved	10b	GEVENT2_L/AGPI03	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	Reserved										
10b	GEVENT2_L/AGPI03										
11b	Reserved										

IOMUXx04 GEVENT4_L_AGPI04

Bits	Description										
7:2	Reserved.										
1:0	GEVENT4_L_AGPI04. Read-write. Reset: 01b. Multi-function IO pin function select for pin GEVENT4_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT4_L/AGPI04</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	GEVENT4_L/AGPI04	10b	Reserved	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	GEVENT4_L/AGPI04										
10b	Reserved										
11b	Reserved										

IOMUXx05 GEVENT7_L_AGPI05

Bits	Description										
7:2	Reserved.										
1:0	GEVENT7_L_AGPI05. Read-write. Reset: 01b. Multi-function IO pin function select for pin GEVENT7_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT7_L/AGPI05</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	GEVENT7_L/AGPI05	10b	Reserved	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	GEVENT7_L/AGPI05										
10b	Reserved										
11b	Reserved										

IOMUXx06 GEVENT10_L_AGPIO6

Bits	Description										
7:2	Reserved.										
1:0	GEVENT10_L_AGPIO6. Read-write. Reset: 01b. Multi-function IO pin function select for pin GEVENT10_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT10_L/AGPIO6</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	GEVENT10_L/AGPIO6	10b	Reserved	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	GEVENT10_L/AGPIO6										
10b	Reserved										
11b	Reserved										

IOMUXx07 GEVENT11_L_AGPIO7

Bits	Description										
7:2	Reserved.										
1:0	GEVENT11_L_AGPIO7. Read-write. Reset: 01b. Multi-function IO pin function select for pin GEVENT11_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT11_L/AGPIO7</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	GEVENT11_L/AGPIO7	10b	Reserved	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	GEVENT11_L/AGPIO7										
10b	Reserved										
11b	Reserved										

IOMUXx08 LPC_SMI_L_AGPIO8

Bits	Description										
7:2	Reserved.										
1:0	LPC_SMI_L_AGPIO8. Read-write. Reset: 00b. Multi-function IO pin function select for pin LPC_SMI_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>LPC_SMI_L</td></tr> <tr> <td>01b</td><td>GEVENT23_L/AGPIO8</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	LPC_SMI_L	01b	GEVENT23_L/AGPIO8	10b	Reserved	11b	Reserved
Bits	Definition										
00b	LPC_SMI_L										
01b	GEVENT23_L/AGPIO8										
10b	Reserved										
11b	Reserved										

IOMUXx09 GEVENT22_L_AGPIO9

Bits	Description
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7:2	Reserved.										
1:0	GEVENT22_L_AGPI09 . Read-write. Reset: 00b. Multi-function IO pin function select for pin GEVENT22_L. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT22_L/AGPI09</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GEVENT22_L/AGPI09	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GEVENT22_L/AGPI09										
10b	Reserved										
11b	Reserved										

IOMUXx0A GPIO174_AGPI010

Bits	Description										
7:2	Reserved.										
1:0	GPIO174_AGPI010 . Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO174. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO174/AGPI010</td></tr> <tr> <td>01b</td><td>S0I3</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO174/AGPI010	01b	S0I3	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO174/AGPI010										
01b	S0I3										
10b	Reserved										
11b	Reserved										

IOMUXx0B BLINK_AGPI011

Bits	Description										
7:2	Reserved.										
1:0	BLINK_AGPI011 . Read-write. Reset: 00b. Multi-function IO pin function select for pin BLINK. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GEVENT18_L/AGPI011</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GEVENT18_L/AGPI011	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GEVENT18_L/AGPI011										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx0C IR_LED_L_LL_B_L_AGPI012

Bits	Description										
7:2	Reserved.										
1:0	IR_LED_L_LL_B_L_AGPI012 . Read-write. Reset: 00b. Multi-function IO pin function select for pin IR_LED_L/LL_B_L. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>IR_LED</td></tr> <tr> <td>01b</td><td>GPIO184/AGPI012</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	IR_LED	01b	GPIO184/AGPI012	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	IR_LED										
01b	GPIO184/AGPI012										
10b	Reserved										
11b	Reserved										

IOMUXx0D IR_TX0_AGPIO13

Bits	Description										
7:2	Reserved.										
1:0	IR_TX0_AGPIO13. Read-write. Reset: 00b. Multi-function IO pin function select for pin IR_TX0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT21_L/IR_TX0/AGPIO13</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GEVENT21_L/IR_TX0/AGPIO13	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GEVENT21_L/IR_TX0/AGPIO13										
10b	Reserved										
11b	Reserved										

IOMUXx0E IR_TX1_AGPIO14

Bits	Description										
7:2	Reserved.										
1:0	IR_TX1_AGPIO14. Read-write. Reset: 01b. Multi-function IO pin function select for pin IR_TX1. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT6_L/IR_TX1/AGPIO14</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GEVENT6_L/IR_TX1/AGPIO14	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GEVENT6_L/IR_TX1/AGPIO14										
10b	Reserved										
11b	Reserved										

IOMUXx0F IR_RX1_AGPIO15

Bits	Description										
7:2	Reserved.										
1:0	IR_RX1_AGPIO15. Read-write. Reset: 00b. Multi-function IO pin function select for pin IR_RX1. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>IR_RX1</td></tr> <tr> <td>01b</td><td>GEVENT20_L/AGPIO15</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	IR_RX1	01b	GEVENT20_L/AGPIO15	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	IR_RX1										
01b	GEVENT20_L/AGPIO15										
10b	Reserved										
11b	Reserved										

IOMUXx10 USB_OC0_L_AGPIO16

Bits	Description										
7:2	Reserved.										
1:0	USB_OC0_L_AGPIO16. Read-write. Reset: 00b. Multi-function IO pin function select for pin USB_OC0_L/SPI_TPM_CS_L/TRST_L. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>USB_OC0_L</td></tr> <tr> <td>01b</td><td>GEVENT12_L/AGPIO16</td></tr> <tr> <td>10b</td><td>LPC_PD</td></tr> <tr> <td>11b</td><td>SPI_TPM_CS_L</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	USB_OC0_L	01b	GEVENT12_L/AGPIO16	10b	LPC_PD	11b	SPI_TPM_CS_L
<u>Bits</u>	<u>Definition</u>										
00b	USB_OC0_L										
01b	GEVENT12_L/AGPIO16										
10b	LPC_PD										
11b	SPI_TPM_CS_L										

IOMUXx11 USB_OC1_L_AGPIO17

Bits	Description										
7:2	Reserved.										
1:0	USB_OC1_L_AGPIO17. Read-write. Reset: 00b. Multi-function IO pin function select for pin USB_OC1_L/TDI. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>USB_OC1_L</td></tr> <tr> <td>01b</td><td>GEVENT13_L/AGPIO17</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	USB_OC1_L	01b	GEVENT13_L/AGPIO17	10b	Reserved	11b	Reserved
Bits	Definition										
00b	USB_OC1_L										
01b	GEVENT13_L/AGPIO17										
10b	Reserved										
11b	Reserved										

IOMUXx12 USB_OC2_L_AGPIO18

Bits	Description										
7:2	Reserved.										
1:0	USB_OC2_L_AGPIO18. Read-write. Reset: 00b. Multi-function IO pin function select for pin USB_OC2_L/TCK. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>USB_OC2_L</td></tr> <tr> <td>01b</td><td>GEVENT14_L/AGPIO18</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	USB_OC2_L	01b	GEVENT14_L/AGPIO18	10b	Reserved	11b	Reserved
Bits	Definition										
00b	USB_OC2_L										
01b	GEVENT14_L/AGPIO18										
10b	Reserved										
11b	Reserved										

IOMUXx13 SCL1_EGPIO19

Bits	Description										
7:2	Reserved.										
1:0	SCL1_EGPIO19. Read-write. Reset: 00b. Multi-function IO pin function select for pin SCL1. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>SCL1</td></tr> <tr> <td>01b</td><td>GPIO227/EGPIO19</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	SCL1	01b	GPIO227/EGPIO19	10b	Reserved	11b	Reserved
Bits	Definition										
00b	SCL1										
01b	GPIO227/EGPIO19										
10b	Reserved										
11b	Reserved										

IOMUXx14 SDA1_EGPIO20

Bits	Description
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7:2	Reserved.										
1:0	SDA1_EGPIO20. Read-write. Reset: 00b. Multi-function IO pin function select for pin SDA1. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>SDA1</td></tr> <tr> <td>01b</td><td>GPIO228/EGPIO20</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	SDA1	01b	GPIO228/EGPIO20	10b	Reserved	11b	Reserved
Bits	Definition										
00b	SDA1										
01b	GPIO228/EGPIO20										
10b	Reserved										
11b	Reserved										

IOMUXx15 LPC_PD_L_AGPIO21

Bits	Description										
7:2	Reserved.										
1:0	LPC_PD_L_AGPIO21. Read-write. Reset: 01b. Multi-function IO pin function select for pin LPC_PD_L/SPI_TPM_CS_L_. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GEVENT5_L/AGPIO21</td></tr> <tr> <td>01b</td><td>LPC_PD_L</td></tr> <tr> <td>10b</td><td>SPI_TPM_CS_L</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GEVENT5_L/AGPIO21	01b	LPC_PD_L	10b	SPI_TPM_CS_L	11b	Reserved
Bits	Definition										
00b	GEVENT5_L/AGPIO21										
01b	LPC_PD_L										
10b	SPI_TPM_CS_L										
11b	Reserved										

IOMUXx16 LPC_PME_L_AGPIO22

Bits	Description										
7:2	Reserved.										
1:0	LPC_PME_L_AGPIO22. Read-write. Reset: 00b. Multi-function IO pin function select for pin LPC_PME_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>LPC_PME_L</td></tr> <tr> <td>01b</td><td>GEVENT3_L/AGPIO22</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	LPC_PME_L	01b	GEVENT3_L/AGPIO22	10b	Reserved	11b	Reserved
Bits	Definition										
00b	LPC_PME_L										
01b	GEVENT3_L/AGPIO22										
10b	Reserved										
11b	Reserved										

IOMUXx17 AC_PRE_S_IR_RX0_AGPIO23

Bits	Description										
7:2	Reserved.										
1:0	AC_PRE_S_IR_RX0_AGPIO23. Read-write. Reset: 01b. Multi-function IO pin function select for pin AC_PRE_S/IR_RX0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>AC_PRE_S</td></tr> <tr> <td>01b</td><td>IR_RX0</td></tr> <tr> <td>10b</td><td>GEVENT16_L/AGPIO23</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	AC_PRE_S	01b	IR_RX0	10b	GEVENT16_L/AGPIO23	11b	Reserved
Bits	Definition										
00b	AC_PRE_S										
01b	IR_RX0										
10b	GEVENT16_L/AGPIO23										
11b	Reserved										

IOMUXx18 USB_OC3_L/TDO_AGPIO24

Bits	Description										
7:2	Reserved.										
1:0	USB_OC3_L_TDO_AGPIO24. Read-write. Reset: 00b. Multi-function IO pin function select for pin USB_OC3_L/TDO. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>USB_OC3_L</td></tr> <tr> <td>01b</td><td>GEVENT15_L/AGPIO24</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	USB_OC3_L	01b	GEVENT15_L/AGPIO24	10b	Reserved	11b	Reserved
Bits	Definition										
00b	USB_OC3_L										
01b	GEVENT15_L/AGPIO24										
10b	Reserved										
11b	Reserved										

IOMUXx19 GEVENT17_L_AGPIO25

Bits	Description										
7:2	Reserved.										
1:0	GEVENT17_L_AGPIO25. Read-write. Reset: 10b. Multi-function IO pin function select for pin GEVENT17_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GEVENT17_L/AGPIO25</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	Reserved	10b	GEVENT17_L/AGPIO25	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	Reserved										
10b	GEVENT17_L/AGPIO25										
11b	Reserved										

IOMUXx1A AZ_SDIN0_EGPIO26

Bits	Description										
7:2	Reserved.										
1:0	AZ_SDIN0_EGPIO26. Read-write. Reset: 00b. Multi-function IO pin function select for pin AZ_SDIN0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>AZ_SDIN0</td></tr> <tr> <td>01b</td><td>GPIO167/EGPIO26</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	AZ_SDIN0	01b	GPIO167/EGPIO26	10b	Reserved	11b	Reserved
Bits	Definition										
00b	AZ_SDIN0										
01b	GPIO167/EGPIO26										
10b	Reserved										
11b	Reserved										

IOMUXx1B AZ_SDIN1_EGPIO27

Bits	Description
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7:2	Reserved.										
1:0	AZ_SDIN1_EGPIO27. Read-write. Reset: 00b. Multi-function IO pin function select for pin AZ_SDIN1. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>AZ_SDIN1</td></tr> <tr> <td>01b</td><td>GPIO168/EGPIO27</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	AZ_SDIN1	01b	GPIO168/EGPIO27	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	AZ_SDIN1										
01b	GPIO168/EGPIO27										
10b	Reserved										
11b	Reserved										

IOMUXx1C AZ_SDIN2_EGPIO28

Bits	Description										
7:2	Reserved.										
1:0	AZ_SDIN2_EGPIO28. Read-write. Reset: 00b. Multi-function IO pin function select for pin AZ_SDIN2. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>AZ_SDIN2</td></tr> <tr> <td>01b</td><td>GPIO169/EGPIO28</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	AZ_SDIN2	01b	GPIO169/EGPIO28	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	AZ_SDIN2										
01b	GPIO169/EGPIO28										
10b	Reserved										
11b	Reserved										

IOMUXx1D AZ_SDIN3_EGPIO29

Bits	Description										
7:2	Reserved.										
1:0	AZ_SDIN3_EGPIO29. Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO29. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>AZ_SDIN3</td></tr> <tr> <td>01b</td><td>GPIO170/EGPIO29</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	AZ_SDIN3	01b	GPIO170/EGPIO29	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	AZ_SDIN3										
01b	GPIO170/EGPIO29										
10b	Reserved										
11b	Reserved										

IOMUXx1E LPCCLK0_EGPIO30

Bits	Description										
7:2	Reserved.										
1:0	LPCCLK0_EGPIO30. Read-write. Reset: 00b. Multi-function IO pin function select for pin LPCCLK0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>LPCCLK0</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	LPCCLK0	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	LPCCLK0										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx1F LPCCLK1_EGPIO31

Bits	Description										
7:2	Reserved.										
1:0	LPCCLK1_EGPIO31. Read-write. Reset: 00b. Multi-function IO pin function select for pin LPCCLK1. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>LPCCLK1</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	LPCCLK1	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	LPCCLK1										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx20 SPI_HOLD_L_EGPIO32

Bits	Description										
7:2	Reserved.										
1:0	SPI_HOLD_L_EGPIO32. Read-write. Reset: 00b. Multi-function IO pin function select for pin SPI_HOLD_L. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GEVENT9_L/EGPIO32</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GEVENT9_L/EGPIO32	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GEVENT9_L/EGPIO32										
10b	Reserved										
11b	Reserved										

IOMUXx21 SPI_CLK_EGPIO33

Bits	Description										
7:2	Reserved.										
1:0	SPI_CLK_EGPIO33. Read-write. Reset: 00b. Multi-function IO pin function select for pin SPI_CLK. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO162/EGPIO33</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO162/EGPIO33	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO162/EGPIO33										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx22 SPI_CS1_L_EGPIO34

Bits	Description
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7:2	Reserved.										
1:0	SPI_CS1_L_EGPIO34. Read-write. Reset: 00b. Multi-function IO pin function select for the corresponding SPI_CS1_L. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00b</td><td>GPIO165/EGPIO34</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO165/EGPIO34	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO165/EGPIO34										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx23 SPI_CS2_L_EGPIO35

Bits	Description										
7:2	Reserved.										
1:0	SPI_CS2_L_EGPIO35. Read-write. Reset: 00b. Multi-function IO pin function select for pin SPI_CS2_L. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00b</td><td>SPI_CS2_L</td></tr> <tr> <td>01b</td><td>Reserved.</td></tr> <tr> <td>10b</td><td>GPIO166/EGPIO35</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	SPI_CS2_L	01b	Reserved.	10b	GPIO166/EGPIO35	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	SPI_CS2_L										
01b	Reserved.										
10b	GPIO166/EGPIO35										
11b	Reserved										

IOMUXx24 SPI_DI_EGPIO36

Bits	Description										
7:2	Reserved.										
1:0	SPI_DI_EGPIO36. Read-write. Reset: 00b. Multi-function IO pin function select for pin SPI_DI. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00b</td><td>GPIO164/EGPIO36</td></tr> <tr> <td>01b</td><td>Reserved.</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO164/EGPIO36	01b	Reserved.	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO164/EGPIO36										
01b	Reserved.										
10b	Reserved										
11b	Reserved										

IOMUXx25 SPI_DO_EGPIO37

Bits	Description										
7:2	Reserved.										
1:0	SPI_DO_EGPIO37. Read-write. Reset: 00b. Multi-function IO pin function select for SPI_DO. <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00b</td><td>GPIO163/EGPIO37</td></tr> <tr> <td>01b</td><td>Reserved.</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO163/EGPIO37	01b	Reserved.	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO163/EGPIO37										
01b	Reserved.										
10b	Reserved										
11b	Reserved										

IOMUXx26 SPI_WP_L_EGPIO38

Bits	Description										
7:2	Reserved.										
1:0	SPI_WP_L_EGPIO38. Read-write. Reset: 00b. Multi-function IO pin function select for pin SPI_WP_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GPIO161/EGPIO38</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	GPIO161/EGPIO38	10b	Reserved	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	GPIO161/EGPIO38										
10b	Reserved										
11b	Reserved										

IOMUXx40 GPIO49_AGPIO64

Bits	Description										
7:2	Reserved.										
1:0	GPIO49_AGPIO64. Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO49. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO49/AGPIO64</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	Reserved	10b	GPIO49/AGPIO64	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	Reserved										
10b	GPIO49/AGPIO64										
11b	Reserved										

IOMUXx41 GPIO50_AGPIO65

Bits	Description										
7:2	Reserved.										
1:0	GPIO50_AGPIO65. Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO50. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Sata_IS2</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO50/AGPIO65</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Sata_IS2	01b	Reserved	10b	GPIO50/AGPIO65	11b	Reserved
Bits	Definition										
00b	Sata_IS2										
01b	Reserved										
10b	GPIO50/AGPIO65										
11b	Reserved										

IOMUXx42 GPIO51_AGPIO66

Bits	Description										
7:2	Reserved.										
1:0	GPIO51_AGPIO66. Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO51. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO51/AGPIO66</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	Reserved	01b	Reserved	10b	GPIO51/AGPIO66	11b	Reserved
Bits	Definition										
00b	Reserved										
01b	Reserved										
10b	GPIO51/AGPIO66										
11b	Reserved										

IOMUXx43 GPIO55_AGPIO67

Bits	Description										
7:2	Reserved.										
1:0	GPIO55_AGPIO67 . Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO55. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>DEVSLP0</td></tr> <tr> <td>11b</td><td>GPIO55/AGPIO67</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	Reserved	10b	DEVSLP0	11b	GPIO55/AGPIO67
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	Reserved										
10b	DEVSLP0										
11b	GPIO55/AGPIO67										

IOMUXx44 GPIO57_AGPIO68

Bits	Description										
7:2	Reserved.										
1:0	GPIO57_AGPIO68 . Read-write. Reset: 00b. Multi-function IO pin function select for GPIO57. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GPIO57/AGPIO68</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GPIO57/AGPIO68	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GPIO57/AGPIO68										
10b	Reserved										
11b	Reserved										

IOMUXx45 GPIO58_AGPIO69

Bits	Description										
7:2	Reserved.										
1:0	GPIO58_AGPIO69 . Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO58. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>GPIO58/AGPIO69</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	GPIO58/AGPIO69	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	GPIO58/AGPIO69										
10b	Reserved										
11b	Reserved										

IOMUXx46 GPIO59_AGPIO70

Bits	Description										
7:2	Reserved.										
1:0	GPIO59_AGPIO70 . Read-write. Reset: 00b. Multi-function IO pin function select for GPIO59. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>DEVSLP1</td></tr> <tr> <td>11b</td><td>GPIO59/AGPIO70</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	Reserved	10b	DEVSLP1	11b	GPIO59/AGPIO70
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	Reserved										
10b	DEVSLP1										
11b	GPIO59/AGPIO70										

IOMUXx47 GPIO64_AGPIOW1

Bits	Description										
7:2	Reserved.										
1:0	GPIO64_AGPIOW1 . Read-write. Reset: 00b. Multi-function IO pin function select for pin GPIO64. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO64/AGPIOW1</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	Reserved	10b	GPIO64/AGPIOW1	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	Reserved										
10b	GPIO64/AGPIOW1										
11b	Reserved										

IOMUXx48 GPIO68_AGPIOW2

Bits	Description										
7:2	Reserved.										
1:0	GPIO68_AGPIOW2 . Read-write. Reset: 10b. Multi-function IO pin function select for pin GPIO68. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO68/AGPIOW2</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO68/AGPIOW2	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO68/AGPIOW2										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx49 GPIO69_AGpio73

Bits	Description										
7:2	Reserved.										
1:0	GPIO69_AGpio73 . Read-write. Reset: 10b. Multi-function IO pin function select for pin GPIO69. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO69/AGPIOW3</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO69/AGPIOW3	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO69/AGPIOW3										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx4C GPIO70_AGPIOW6

Bits	Description										
7:2	Reserved.										
1:0	GPIO70_AGPIOW6 . Read-write. Reset: 10b. Multi-function IO pin function select for pin GPIO70 . <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO70/AGPIOW6</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO70/AGPIOW6	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO70/AGPIOW6										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx4D GPIO71_AGPIOW7

Bits	Description										
7:2	Reserved.										
1:0	GPIO71_AGPIOW7 . Read-write. Reset: 01b. Multi-function IO pin function select for pin GPIO71. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO71/AGPIOW7</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GPIO71/AGPIOW7	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GPIO71/AGPIOW7										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx54 FANIN0_EGPIO84

Bits	Description										
7:2	Reserved.										
1:0	FANIN0_EGPIO84 . Read-write. Reset: 00b. Multi-function IO pin function select for pin FANIN0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>FANIN0</td></tr> <tr> <td>01b</td><td>GPIO56/EGPIO84</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	FANIN0	01b	GPIO56/EGPIO84	10b	Reserved	11b	Reserved
Bits	Definition										
00b	FANIN0										
01b	GPIO56/EGPIO84										
10b	Reserved										
11b	Reserved										

IOMUXx55 FANOUT0_EGPIO85

Bits	Description										
7:2	Reserved.										
1:0	FANOUT0_EGPIO85 . Read-write. Reset: 00b. Multi-function IO pin function select for pin FANOUT0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>FANOUT0</td></tr> <tr> <td>01b</td><td>GPIO52/EGPIO85</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	FANOUT0	01b	GPIO52/EGPIO85	10b	Reserved	11b	Reserved
Bits	Definition										
00b	FANOUT0										
01b	GPIO52/EGPIO85										
10b	Reserved										
11b	Reserved										

IOMUXx57 SERIRQ_EGPIO87

Bits	Description										
7:2	Reserved.										
1:0	SERIRQ_EGPIO87 . Read-write. Reset: 00b. Multi-function IO pin function select for pin SERIRQ. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>SERIRQ</td></tr> <tr> <td>01b</td><td>GPIO48/EGPIO87</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	SERIRQ	01b	GPIO48/EGPIO87	10b	Reserved	11b	Reserved
Bits	Definition										
00b	SERIRQ										
01b	GPIO48/EGPIO87										
10b	Reserved										
11b	Reserved										

IOMUXx58 LPC_CLKRUN_L_EGPIO88

Bits	Description										
7:2	Reserved.										
1:0	LPC_CLKRUN_L_EGPIO88. Read-write. Reset: 00b. Multi-function IO pin function select for LPC_CLKRUN_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>LPC_CLKRUN_L</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	LPC_CLKRUN_L	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	LPC_CLKRUN_L										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx59 GENINT1_L_AGPIO89

Bits	Description										
7:2	Reserved.										
1:0	GENINT1_L_AGPIO89. Read-write. Reset: 00b. Multi-function IO pin function select for GENINT1_L. This pin can be configured as either GPIO output, or interrupt GENINT1. To use the pin as interrupt input, configure its GPIO register properly to set the pin as input mode and configure the IRQ routing (IOC00/IOC01) registers and IOAPIC/PIC registers. To use the pin as GPIO output, keep its IRQ routing register (IOC00/IOC01) at default value which disables the interrupt path. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO32/AGPIO89</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GPIO32/AGPIO89	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GPIO32/AGPIO89										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx5A GENINT2_L_AGPIO90

Bits	Description										
7:2	Reserved.										
1:0	GENINT2_L_AGPIO90. Read-write. Reset: 00b. Multi-function IO pin function select for GENINT2_L. This pin can be configured as either GPIO output, or interrupt GENINT2. To use the pin as interrupt input, configure its GPIO register properly to set the pin as input mode and configure the IRQ routing (IOC00/IOC01) registers and IOAPIC/PIC registers. To use the pin as GPIO output, keep its IRQ routing register (IOC00/IOC01) at default value which disables the interrupt path. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO33/AGPIO90</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GPIO33/AGPIO90	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GPIO33/AGPIO90										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx5B SPKR_AGPI091

Bits	Description										
7:2	Reserved.										
1:0	SPKR_AGPI091. Read-write. Reset: 00b. Multi-function IO pin function select for pin AGPI091. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>SPKR</td></tr> <tr> <td>01b</td><td>GPIO66/AGPI091</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	SPKR	01b	GPIO66/AGPI091	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	SPKR										
01b	GPIO66/AGPI091										
10b	Reserved										
11b	Reserved										

IOMUXx5C CLK_REQ0_L_AGPI092

Bits	Description										
7:2	Reserved.										
1:0	CLK_REQ0_L_AGPI092. Read-write. Reset: 00b. Multi-function IO pin function select for pin CLK_REQ0_L/SATA_IS0_L/SATA_ZP0_L. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>CLK_REQ0_L</td></tr> <tr> <td>01b</td><td>SATA_IS0_L</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>SATA_ZP0_L/GPIO60/AGPI092</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	CLK_REQ0_L	01b	SATA_IS0_L	10b	Reserved	11b	SATA_ZP0_L/GPIO60/AGPI092
<u>Bits</u>	<u>Definition</u>										
00b	CLK_REQ0_L										
01b	SATA_IS0_L										
10b	Reserved										
11b	SATA_ZP0_L/GPIO60/AGPI092										

IOMUXx5D SD_LED_EGPI093

Bits	Description										
7:2	Reserved.										
1:0	SD_LED_EGPI093. Read-write. Reset: 01b. Multi-function IO pin function select for pin SD_LED. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Reserved</td></tr> <tr> <td>01b</td><td>SD_LED</td></tr> <tr> <td>10b</td><td>GPIO45/EGPI093</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Reserved	01b	SD_LED	10b	GPIO45/EGPI093	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	Reserved										
01b	SD_LED										
10b	GPIO45/EGPI093										
11b	Reserved										

IOMUXx5E SD_CD_EGPI094

Bits	Description										
7:2	Reserved.										
1:0	SD_CD_EGPI094. Read-write. Reset: 01b. Multi-function IO pin function select for pin SD_CD. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>GPIO75/EGPI094</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	GPIO75/EGPI094	01b	Reserved	10b	Reserved	11b	Reserved
<u>Bits</u>	<u>Definition</u>										
00b	GPIO75/EGPI094										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx5F SD_CLK_EGPIO95

Bits	Description										
7:2	Reserved.										
1:0	SD_CLK_EGPIO95. Read-write. Reset: 01b. Multi-function IO pin function select for pin SD_CLK. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO73/EGPIO95</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GPIO73/EGPIO95	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GPIO73/EGPIO95										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx60 SD_CMD_EGPIO96

Bits	Description										
7:2	Reserved.										
1:0	SD_CMD_EGPIO96. Read-write. Reset: 01b. Multi-function IO pin function select for pin SD_CMD. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO74/EGPIO96</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GPIO74/EGPIO96	01b	Reserved	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GPIO74/EGPIO96										
01b	Reserved										
10b	Reserved										
11b	Reserved										

IOMUXx[64:61] SD_DATA[3:0]_EGPIO[100:97]

Bits	Description										
7:2	Reserved.										
1:0	EGPIO_SD_DATA[3:0]. Read-write. Reset: 00b. Multi-function IO pin function select for SD_DATA[3:0] <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO[80:77]/EGPIO[100:97]</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	GPIO[80:77]/EGPIO[100:97]	01b	Reserved	10b	Reserved	11b	Reserved.
Bits	Definition										
00b	GPIO[80:77]/EGPIO[100:97]										
01b	Reserved										
10b	Reserved										
11b	Reserved.										

IOMUXx65 SD_WP_EGPIO101

Bits	Description
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7:2	Reserved.										
1:0	SD_WP_EGPIO101. Read-write. Reset: 00b. Multi-function IO pin function select for SD_WP										
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO76/EGPIO101</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	GPIO76/EGPIO101	01b	Reserved	10b	Reserved	11b	Reserved.
Bits	Definition										
00b	GPIO76/EGPIO101										
01b	Reserved										
10b	Reserved										
11b	Reserved.										

IOMUXx71 SCL0_EGPIO113

Bits	Description										
7:2	Reserved.										
1:0	SCL0_EGPIO113. Read-write. Reset: 00b. Multi-function IO pin function select for SCL0.										
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO43/EGPIO113</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	GPIO43/EGPIO113	01b	Reserved	10b	Reserved	11b	Reserved.
Bits	Definition										
00b	GPIO43/EGPIO113										
01b	Reserved										
10b	Reserved										
11b	Reserved.										

IOMUXx72 SDA0_EGPIO114

Bits	Description										
7:2	Reserved.										
1:0	SDA0_EGPIO114. Read-write. Reset: 00b. Multi-function IO pin function select for SDA0.										
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GPIO47/EGPIO114</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	GPIO47/EGPIO114	01b	Reserved	10b	Reserved	11b	Reserved.
Bits	Definition										
00b	GPIO47/EGPIO114										
01b	Reserved										
10b	Reserved										
11b	Reserved.										

IOMUXx73 CLK_REQ1_L_EGPIO115

Bits	Description										
7:2	Reserved.										
1:0	CLK_REQ1_L_EGPIO115. Read-write. Reset: 00b. Multi-function IO pin function select for pin CLK_REQ1_L.										
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>CLK_REQ1_L</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO61/EGPIO115</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	CLK_REQ1_L	01b	Reserved	10b	GPIO61/EGPIO115	11b	Reserved
Bits	Definition										
00b	CLK_REQ1_L										
01b	Reserved										
10b	GPIO61/EGPIO115										
11b	Reserved										

IOMUXx74 CLK_REQ2_L_EGPIO116

Bits	Description										
7:2	Reserved.										
1:0	CLK_REQ2_L_EGPIO116. Read-write. Reset: 00b. Multi-function IO pin function select for pin CLK_REQ2_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>CLK_REQ2_L</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>GPIO62/EGPIO116</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	CLK_REQ2_L	01b	Reserved	10b	GPIO62/EGPIO116	11b	Reserved
Bits	Definition										
00b	CLK_REQ2_L										
01b	Reserved										
10b	GPIO62/EGPIO116										
11b	Reserved										

IOMUXx7E GA20IN_AGPIO126

Bits	Description										
7:2	Reserved.										
1:0	GA20IN_AGPIO126. Read-write. Reset: 00b. Multi-function IO pin function select for pin GA20IN. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>GA20IN</td></tr> <tr> <td>01b</td><td>GEVENT0_L/AGPIO126</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	GA20IN	01b	GEVENT0_L/AGPIO126	10b	Reserved	11b	Reserved
Bits	Definition										
00b	GA20IN										
01b	GEVENT0_L/AGPIO126										
10b	Reserved										
11b	Reserved										

IOMUXx81 KBRST_L_AGPIO129

Bits	Description										
7:2	Reserved.										
1:0	KBRST_L_AGPIO129. Read-write. Reset: 00b. Multi-function IO pin function select for pin KBRST_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>KBRST_L</td></tr> <tr> <td>01b</td><td>GEVENT1_L/AGPIO129</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	KBRST_L	01b	GEVENT1_L/AGPIO129	10b	Reserved	11b	Reserved
Bits	Definition										
00b	KBRST_L										
01b	GEVENT1_L/AGPIO129										
10b	Reserved										
11b	Reserved										

IOMUXx82 SATA_ACT_L_AGPIO130

Bits	Description
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7:2	Reserved.										
1:0	SATA_ACT_L_AGPIO130. Read-write. Reset: 00b. Multi-function IO pin function select for pin SATA_ACT_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>SATA_ACT_L</td></tr> <tr> <td>01b</td><td>GPIO67/AGPIO130</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>	Bits	Definition	00b	SATA_ACT_L	01b	GPIO67/AGPIO130	10b	Reserved	11b	Reserved
Bits	Definition										
00b	SATA_ACT_L										
01b	GPIO67/AGPIO130										
10b	Reserved										
11b	Reserved										

IOMUXx83 CLK_REQ3_L_EGPIO131

Bits	Description										
7:2	Reserved.										
1:0	CLK_REQ3_L_EGPIO131. Read-write. Reset: 00b. Multi-function IO pin function select for pin CLK_REQ3_L/SATA_IS1_L/SATA_ZP1_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>CLK_REQ3_L</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>SATA_ZP1_L/GPIO63/EGPIO131</td></tr> </table>	Bits	Definition	00b	CLK_REQ3_L	01b	Reserved	10b	Reserved	11b	SATA_ZP1_L/GPIO63/EGPIO131
Bits	Definition										
00b	CLK_REQ3_L										
01b	Reserved										
10b	Reserved										
11b	SATA_ZP1_L/GPIO63/EGPIO131										

IOMUXx84 CLK_REQG_L_EGPIO132

Bits	Description										
7:2	Reserved.										
1:0	CLK_REQG_L_EGPIO132. Read-write. Reset: 00b. Multi-function IO pin function select for pin CLK_REQG_L. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>CLK_REQG_L</td></tr> <tr> <td>01b</td><td>GPIO65/EGPIO132</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	CLK_REQG_L	01b	GPIO65/EGPIO132	10b	Reserved	11b	Reserved.
Bits	Definition										
00b	CLK_REQG_L										
01b	GPIO65/EGPIO132										
10b	Reserved										
11b	Reserved.										

3.26.13 Power Management (PM) Registers

PM register space is accessed through two methods:

- Indirect IO access through [IOCD6 \[PM_Index\]](#) and [IOCD7 \[PM_Data\]](#). Software first programs the offset into the index register [IOCD6](#) and then reads from or writes to the data register [IOCD7](#).
- Direct memory mapped access through the AcpiMmio region. The PM registers range from FED8_0000h+300h to FED8_0000h+3FFh. See [PMx04\[MmioEn\]](#) for details on the AcpiMmio region.

PMx00 DecodeEn

Bits	Description			
31:30	Reserved.			
29	HpetMsiEn. Read-write. Reset: 1. 1=Expose MSI capability in HPET Capbility register.			
28	HpetWidthSel. Read-write. Reset: 0. 0=HPET is 32-bit. 1=HPET is 64-bit.			
27:26	WatchDogOptions. Read-write. Reset: 00b. 00b=Enable WatchDogTimer.			
25:24	WatchDogFreq. Read-write. Reset: 11b. Defines the clock frequency used by the WatchDogTimer.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	32 us	10b	100 ms
	01b	10 ms	11b	1 s
23:21	AsfClkSel. Read-write. Reset: 000b. Specifies the frequency of ASF master clock.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	0h	~100 kHz	4h	~600 kHz
	1h	~200 kHz	5h	~800 kHz
	2h	~300 kHz	6h	~900 kHz
	3h	~400 kHz	7h	~1 MHz
20:19	Smbus0Sel. Read-write. Reset: 0. Specifies SMBus port selection. There is only one SMBus engine controlling four SMBus ports. This register routes the SMBus engine to the desired port.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00b	Port 0, for SMBUS on the board	10b	Port 3, Reserved
	01b	Port 2, dedicated for TSI polling	11b	Port 4, Reserved
18	AsfClkSwitch. Read-write. Reset: 0. 1=Change ASF master clock from RTC(32 kHz) to the clock defined in AsfClkSel.			
17	AsfClkStretchEn. Read-write. Reset: 1. 1=Enable clock stretching support.			
16	AsfSmbMasterEn. Read-write. Reset: 0. 1=Enable ASF SMBus master function.			
15:8	SmbusAsfIoBase. Read-write. Reset: 0Bh. Specifies SMBus and ASF IO base address. • SMBus IO base={Smbus0AsfIoBase[7:0], 0x00}. • ASF IO base={Smbus0AsfIoBase[7:0], 0x20}. By default SMBus IO base is 0xB00 and ASF IO base is 0xB20.			
7	WatchdogTmrEn. Read-write. Reset: 0. 1=Enable Watchdog Timer memory (FEB0_0000h ~ FEB0_000Fh) decoding.			
6	HpetEn. Read-write. Reset: 0. 1=Enable HPET memory (FED0_0000h ~ FED0_01FFh) decoding.			
5	IoApicEn. Read-write. Reset: 0. 1=Enable IOAPIC memory (FEC0_0000h ~ FEC0_007Fh) decoding.			
4	SmbusAsfIoEn. Read-write. Reset: 0. 1=Enable SMBus and ASF IO decoding. SMBUS and ASF IO range are defined in Smbus0AsfIoBase.			
3	DmaPort80. Read-write. Reset: 0. 1=Pass IO port 0x80, 0x81, 0x82, 0x83 to legacy DMA IO range.			

2	LegacyDmaIoEn. Read-write. Reset: 0. 1=Enable legacy DMA IO range.
1	CF9IoEn. Read-write. Reset: 0. 1=Enable CF9h IO port decoding.
0	LegacyIoEn. Read-write. Reset: 0. 1=Enable the following IO decoding: <ul style="list-style-type: none"> • 0x20, 0x21, 0xA0, 0xA1 (PIC); • 0x40, 0x41, 0x42, 0x43, 0x61 (8254 timer); • 0x70, 0x71, 0x72, 0x73 (RTC); • 0x92.

PMx04 IsaControl

Bits	Description
31:25	Reserved.
24	Reserved.
23:22	Reserved.
21:17	Reserved.
16	ABClkGateEn. Read-write. Reset: 0. BIOS: See 2.17.9.2 [Global A-Link / B-Link Clock Gating] . Master switch for ALink and Blink clock gating. 0=Disabled. 1=Enabled.
15:12	Reserved.
11	Reserved.
10	Reserved.
9:8	Reserved.
7:6	Reserved.
5	ReadShadow. Read-write. Reset: 0. 1=Allow to read PIC ICWX, OCWX register through IO port 21h&A1h.
4	LTEnable. Read-write. Reset: 0. Specifies the legacy DMA transfer size.
3:2	Reserved.

1	MmioEn. Read-write. Reset: 0. BIOS: 1. 1=Enable Acpi MMIO range (FED8_0000h-FED8_1FFFh). The space is allocated as followed: 00FFh-0000h SMBus PCI configuration registers, see D14F0x00 . 01FFh-0100h Reserved. 02FFh-0200h SMI, see SMIx00 . 03FFh-0300h PMIO, see PMx00 . 04FFh-0400h PMIO2, see PM2x00 . 05FFh-0500h BIOS RAM 06FFh-0600h CMOS RAM, see IO073_x00 . 07FFh-0700h CMOS 08FFh-0800h ACPI, see 3.26.15 [Standard ACPI Registers] . 09FFh-0900h ASF registers, see ASFx00 . 0AFFh-0A00h SMBus registers, see SMBUSx00 0BFFh-0B00h Watchdog registers, see WDTx00 . 0CFFh-0C00h HPET, see HPETx000 . 0DFFh-0D00h IOMux, see 3.26.12.2 [IOMux Registers] . 0EFFh-0E00h Miscellaneous registers, see MISCx00 . 10FFh-1000h Reserved. 13FFh-1100h Reserved 14FFh-1400h DP-VGA 15FFh-1500h GPIO Bank 0 16FFh-1600h GPIO Bank 1 17FFh-1700h GPIO Bank 2 1BFFh-1800h Reserved 1CFFh-1C00h USB3 PHY, see XHCL_PMx00 . 1DFFh-1D00h Wake Device (AC DC timer), see AcDcTimerx00 . 1EFFh-1E00h Reserved. 1FFFh-1F00h Reserved
0	BiosRamEn. Read-write. Reset: 0. 1=Enable BIOS RAM whose base is FED1_0000h (256 bytes).

PMx08 PciControl

Bits	Description
31:26	Reserved.
25	ForceSlpStateRetry. Read-write. Reset: 0. 1=Send out SMI message before the completion response of IO writes to AcpiPm1CntBlkx00[SlpTyp] . This is to be used in conjunction with SMI trapping on writes to AcpiPm1CntBlkx00[SlpTyp] .
24	ForceStpClkRetry. Read-write. Reset: 1. 1=Send out STPCLK message before the completion response to the following 3 types of requests: <ul style="list-style-type: none"> • IO writes to AcpiPm1CntBlkx00[SlpTyp]. • IO write LDT_STP command. • C1e cycle. Normally it is required to send out STPCLK before completion of the cycles listed above, except for the case of SMI trapping. In the case of SMI trapping, this bit should be programmed as 0.
23	AbStallEn. Read-write. Reset: 0. 1=Allow the legacy DMA engine to hold the internal bus before completing legacy DMA on the LPC bus. This is only needed for certain old LPC devices.
22:21	Reserved.

20	ShutDownOption. Read-write. Reset: 0. 0=Issue Init message upstream when receiving shutdown message. 1=Generate PCI reset when receiving shutdown message.
19	MasterNoWait. Read-write. Reset: 0. 1=ACPI PCI Master doesn't wait for Slave idle when it wants to request bus. 0=PCI Master will wait for Slave idle.
18	Reserved.
17	ChangeDma. Read-write. Reset: 0.
16	GateDma. Read-write. Reset: 0.
15	ClockSlowMask. Read-write. Reset: 0.
14:12	ExtIntrTime. Read-write. Reset: 0. Specifies the extended interrupt time in 2 microsecond intervals. This is used for preventing APU from re-entering C state right away when it just breaks out from a C state.
11	DlyEn. Read-write. Reset: 0.
10	IgnrUsbSmiReq. Read-write. Reset: 1.
9	BlockAcpiS5IntrSt. Read-write. Reset: 0.
8	PicApicArbiter. Read-write. Reset: 1. 1=Enable arbitration between PIC request and IOAPIC request.
7	ForceSmafMatch. Read-write. Reset: 0. 1=Enable STPGNT message matching to the expected SMAF.
6	MtsAuto. Read-write. Reset: 0. 1=Encode PIC interrupt request as legacy PIC ExtInt message type and PIC NMI request as legacy PIC NMI message type if IOAPIC is enabled && MtsSet==0.
5	MtsSet. Read-write. Reset: 1. 1=Encode PIC interrupt request as legacy PIC ExtInt message type and NMI request as legacy NMI message type. 0=Encode PIC interrupt request as ExtInt message type and NMI request as NMI message type.
4	MsgIntrEnable. Read-write. Reset: 0. 1=Deliver legacy PIC interrupt as message type.
3	MaskMsgBmStsEn. Read-write. Reset: 0. 1=Enable A20#, IGNNE#, INIT#, NMI, SMI# message delivery.
2	FakeDmaEn. Read-write. Reset: 0.
1	UndoWrtdtDone. Read-write. Reset: 0.
0	UndoDmaChange. Read-write. Reset: 0.

PMx0C StpClkSmaf

Bits	Description
31	Reserved.
30:28	TtSmaf. Read-write. Reset: 5h. Specifies the system management action field for thermal throttling STPCLK message.
27	Reserved.
26:24	NsSmaf. Read-write. Reset: 5h. Specifies the system management action field for normal throttling STPCLK message.
23	Reserved.
22:20	S3Smaf. Read-write. Reset: 4h. Specifies the system management action field for S3 STPCLK message.

19	Reserved.
18:16	S1Smaf. Read-write. Reset: 3h. Specifies the system management action field for S1 STPCLK message.
15	Reserved.
14:12	VfSmaf. Read-write. Reset: 2h. Specifies the system management action field for VFID STPCLK message.
11	Reserved.
10:8	C3Smaf. Read-write. Reset: 1. Specifies the system management action field for C3 STPCLK message.
7	Reserved.
6:4	C2Smaf. Read-write. Reset: 0. Specifies the system management action field for C2 STPCLK message.
3	Reserved.
2:0	S4S5Smaf. Read-write. Reset: 6h. Specifies the system management action field for S4/5 STPCLK message.

PMx44 BootTimerEn

Bits	Description
31	BootTmrDisable. Read-write. Cold reset: 0. BIOS: 1. 0=Boot timer starts running. 1=Boot timer is stopped; it will not trigger a system reset or de-assertion on the NbPwrGood. Software should set the bit to 1 after every reset or S3/S4/S5 resume before the timer expires in 1.17 s.
30	FailBootRstSts. Write-1-to-clear; Read. Cold reset: 0. 0=Boot timer has not been fired. 1=Boot timer has been fired.
29	ExpireBootTmr. Read-write. Cold reset: 0. 1=Force boot timer to expire; then NbPwrGood can be asserted.
28	BootTmrStopOnGAlink. Read-write. Cold reset: 1. BIOS: 0. 0=Enable the boot timer to ensure a good boot. 1=Boot timer stops when FCH observes a good boot after PCI reset or S3/S4/S5 resume.
27	BootTmrFuncEn. Read-write. Cold reset: 1. BIOS: 1. 0=Disable boot timer function; avoid system restarts when performing BIOS debug. 1=Enable boot timer function; the boot timer starts to count down and will toggle NbPwrGood after 1.17 s if software has not set ExpireBootTmr to 1 after PCI reset or resuming from S3/S4/S5.
26:25	Reserved.
24:0	FailBootTimer. Read-write. Cold reset: 0. Specifies the counter of APU boot timer (14.318 MHz), which starts counting when both of the following conditions are met: <ul style="list-style-type: none"> • BootTmrDisable==1. • PCI reset is not asserted.

PMx54 SerialIrqConfig

Bits	Description
15:14	Reserved.
13:12	Reserved.

11	Reserved.								
10	UndoSerIrqChange . Read-write. Reset: 0.								
9	LegacyDis . Read-write. Reset: 0.								
8	SirqCntrl . Read-write. Reset: 0.								
7	SerialIrqEnable . Read-write. Cold reset: 0. 1=Enable the serial IRQ function.								
6	SerIrqMode . Read-write. Cold reset: 0. 0=Continuous mode. 1=Active (quiet) mode.								
5:2	<p>NumSerIrqBits. Read-write. Cold reset: 0. Specifies the total number of serial IRQs.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>17 serial IRQs (15 IRQ#, SMI#, IOCHK#)</td></tr> <tr> <td>1</td><td>18 serial IRQs (15 IRQ#, SMI#, IOCHK#, INTA#)</td></tr> <tr> <td>15-2</td><td><NumSerIrqBits+17></td></tr> </table> <p>The serial IRQ can support 15 IRQ#, SMI#, IOCHK#, INTA#, INTB#, INTC#, and INTD#. When serial SMI# is used,</p>	Bits	Definition	0	17 serial IRQs (15 IRQ#, SMI#, IOCHK#)	1	18 serial IRQs (15 IRQ#, SMI#, IOCHK#, INTA#)	15-2	<NumSerIrqBits+17>
Bits	Definition								
0	17 serial IRQs (15 IRQ#, SMI#, IOCHK#)								
1	18 serial IRQs (15 IRQ#, SMI#, IOCHK#, INTA#)								
15-2	<NumSerIrqBits+17>								
1:0	NumStartBits . Read-write. Cold reset: 0. This field specifies the number of clocks in the start frame. Start Frame Width = 4 + 2 * NumStartBits.								

PMx56 RTC Control

Bits	Description
15	Reserved.
14	ExtraRtcCmosEn . Read-write. Cold reset: 0. 1=Software can access the extra 16 bytes of RTC CMOS RAM through IO072 and IO073 ; The extra RAM space are located at index 0x00-0x03, 0x40-0x43, 0x80-0x83, 0xC0-0xC3. 0=Access to the extra RTC CMOS RAM space is disabled.
13	AltCmosMapEn . Read-write. Cold reset: 0. 1=When accessing the RTC CMOS RAM through IO070 and IO071 , Bank 1 of CMOS RAM is changed: Index 0Dh:00h still returns the time and alarm settings; Index 7Fh:0Eh returns the absolute offset FFh:8Eh which map to the extended RAM space.
12	CenturyEn . Read-write. Cold reset: 1. 1=Enable RTC Century support.
11	MaskRtcClkOut . Read-write. Cold reset: 0. 0=Disable RtcClk output.
10	RtcClkDrive . Read-write. Cold reset: 1. 0=HIGHDRIVE is tied low for RtcClkOut pad. 1=HIGH-DRIVE is tied high for RtcClkOut pad.
9:7	Reserved.
6	Reserved.
5	Reserved.
4	RtcProtectC0_CF . Write-once. Cold reset: 0. 1=RTC RAM index CFh:C0h are locked from read/write.
3	RtcProtectD0_DF . Write-once. Cold reset: 0. 1=RTC RAM index DFh:D0h are locked from read/write.
2	RtcProtectE0_EF . Write-once. Cold reset: 0. 1=RTC RAM index EFh:E0h are locked from read/write.
1	RtcProtectF0_FF . Write-once. Cold reset: 0. 1=RTC RAM index FFh:F0h are locked from read/write.
0	RtcProtect38_3F . Write-once. Cold reset: 0. 1=RTC RAM index 3Fh:38h are locked from read/write.

PMx58 VRT_T1

Bits	Description
7:0	VRT_T1 . Read-write. Cold reset: 1. This field specifies the time of VRT_Enable being high for RTC battery monitor circuit in milliseconds. To conserve power, the RTC battery is sampled periodically for checking its state of health. VRT_T1 and PMx59[VRT_T2] make up the interval of the checking. When VRT_Enable is high, the battery is being sampled. When VRT_Enable is low, the battery is not being sampled.

PMx59 VRT_T2

Bits	Description
7:0	VRT_T2 . Read-write. Cold reset: FFh. This field specifies the time of VRT_Enable being low for the RTC battery monitor circuit in 4 ms increments. See PMx58 [VRT_T1] for detailed description.

PMx5B RTC Shadow

Bits	Description
7:4	Reserved.
3:0	PwrFailShadow . Read-write. Cold reset: 0. BIOS: 0100b.

PMx5C LLBCntrl

Bits	Description
7:3	Reserved.
2	AllowWakeS3En . Read-write. Cold reset: 0. 1=Allow LLB# as wake event in S3. Note: LLB (Low low battery) event should trigger a SCI if system is in S0. It should block wake-up if the system is in S-States. To meet that required behavior, software should use the following settings: LLB_En (PMxC8[10]) = 1. BlockWakeEn = 0. UseAsWakeEn = 1. AllowWakeS3En = 0 or 1 (don't care).
1	UseAsWakeEn . Read-write. Cold reset: 0. 1=Treat LLB# as wake event.
0	BlockWakeEn . Read-write. Cold reset: 0. 1=Block wake event if LLB# is asserted; if (UseAsWakeEn==1) && (AllowWakeS3En==1), LLB# and other wake events can wake the system up from S3.

PMx5E RTC ExtIndex

Bits	Description
7:0	Index . Read-write. Cold reset: X. Specifies the offset of the RTC Extended Register to be read/written from PMx5F .

PMx5F RTC ExtData

Bits	Description
7:0	Data . Read-write. Cold reset: X. Specifies the read data or write data of the RTC Extended Register.

PMx5F_x00 RTCEXT DltSavEnable

Bits	Description
7:1	Reserved.
0	DltSavEnable . Read-write. Reset: 0. 1=Enable RTC daylight saving feature.

PMx5F_x01 RTCEXT SprFwdCtrl

Bits	Description
7	Reserved.
6	SprFwdWeek . Read-write. Reset: 0. This specifies which Sunday morning to do the “spring forward”. Spring forward is usually at the 1st Sunday of April in United States and last Sunday of March in Europe. 0=The 1st Sunday of the month. 1=The last Sunday of the month.
5:0	SprFwdHour . Read-write. Reset: 0. This Binary-Coded Decimal (BCD) value specifies which hour (24 hour mode) to do the “spring forward”. Spring forward is usually 2 am in United States and 1 am in Europe. 0=2 am. 02h=2 am.

PMx5F_x02 RTCEXT SprFwdMonth

Bits	Description
7:5	Reserved.
4:0	SprFwdMonth . Read-write. Reset: 0. This Binary-Coded Decimal (BCD) value determines which month to do the “spring forward”.

PMx5F_x03 RTCEXT FallBackCtrl

Bits	Description
7	Reserved.
6	FallBackWeek . Read-write. Reset: 0. This value specifies which Sunday morning to do the “fall back”.
5:0	FallBackHour . Read-write. Reset: 0. This Binary-Coded Decimal (BCD) value specifies which hour (24 hour mode) to do the “fall back”. Fall back is usually 2 am in United States and 1 am in Europe. 0=2 am. 02h=2 am.

PMx5F_x04 RTCEXT FallBackMonth

Bits	Description
7:5	Reserved.
4:0	FallBackMonth. Read-write. Reset: 0. This Binary-Coded Decimal (BCD) value specifies which month to “fall back”.

PMx5F_x10 RTCEXT WeekTimerControl

The 16-bit Week Timer is a battery-powered down counter timer that supports 1ms, 1 second, and 1 minute resolution and auto reloads when the timer reaches 0. The WEEK_ALRM interrupt is asserted when the timer reaches 0 and stays asserted until the timer is disabled.

Bits	Description												
7:3	Reserved.												
2:1	Resolution. Read-write. Reset: 0. This field specifies the resolution of the Week Timer counter. Before programing this bit, software should program Enable to 0 to disable the Week Timer. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>1 minute</td><td>10b</td><td>1 ms</td></tr><tr><td>01b</td><td>1 second</td><td>11b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	1 minute	10b	1 ms	01b	1 second	11b	Reserved
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	1 minute	10b	1 ms										
01b	1 second	11b	Reserved										
0	Enable. Read-write. Reset: 0. 0=Disable Week Timer. 1=Enable Week Timer.												

PMx5F_x11 RTCEXT WeekTimerReloadLow

Bits	Description
7:0	WeekTimerReloadLow. Read-write. Reset: 0. This field is used to program the lower 8 bits of the 16-bit WeekTimerReload register. Writing the WeekTimerReloadLow register causes the 16-bit WeekTimerReload to be written into the Week Timer. Software should program PMx5F_x10[Enable] = 0 before writing to this register.

PMx5F_x12 RTCEXT WeekTimerReloadHigh

Bits	Description
7:0	WeekTimerReloadHigh. Read-write. Reset: 0. This field is used to program the upper 8 bits of the 16-bit WeekTimerReload register. This field should be programmed before programming PMx5F_x11 [RTCEXT WeekTimerReloadLow]. Software should program PMx5F_x10[Enable] to 0 before writing to this register.

PMx5F_x13 RTCEXT WeekTimerDataLow

Bits	Description
7:0	WeekTimerDataLow. Read-only. Reset: 0. This field is used to read the current state of the 16-bit Week Timer. Reading from the WeekTimerDataLow register returns the lower 8 bits of the 16-bit Week Timer and causes the upper 8 bits to be latched into PMx5F_x14 [RTCEXT WeekTimerDataHigh] .

PMx5F_x14 RTCEXT WeekTimerDataHigh

Bits	Description
7:0	WeekTimerDataHigh. Read-only. Reset: 0. This field is used to read the current state of the 16-bit Week Timer. Reading from the WeekTimerDataHigh register returns the upper 8 bits of the 16-bit Week Timer latched by a previous read from PMx5F_x11 [RTCEXT WeekTimerReloadLow] .

PMx60 AcpiPm1EvtBlk

Bits	Description
15:2	AcpiPm1EvtBlk. Read-write. Cold reset: 0. Specifies the 16-bit IO range base address[15:2] of the ACPI power management event block defined in 3.26.15.1 [AcpiPmEvtBlk] .
1:0	Reserved.

PMx62 AcpiPm1CntBlk

Bits	Description
15:1	AcpiPm1CntBlk. Read-write. Cold reset: 0200h. Specifies the 16-bit IO base address[15:1] of the ACPI power management control block defined in 3.26.15.2 [AcpiPm1CntBlk] .
0	Reserved.

PMx64 AcpiPmTmrBlk

Bits	Description
15:1	AcpiPmTmrBlk. Read-write. Cold reset: 0. Specifies the 16-bit IO base address[15:1] of the ACPI power management timer block defined in 3.26.15.4 [AcpiPmTmrBlk] .
0	Reserved.

PMx66 CpuCntBlk

Bits	Description
15:3	CpuControl. Read-write. Cold reset: 0. Specifies the 16-bit IO base address[15:3] of the ACPI power management CPU control block defined in 3.26.15.5 [CpuCntBlk] .
2:0	Reserved.

PMx68 AcpiGpe0Blk

Bits	Description
15:2	AcpiGpe0Blk . Read-write. Cold reset: 0. Specifies the 16-bit IO base address[15:2] of the ACPI power management general purpose event block defined in 3.26.15.6 [AcpiGpe0Blk] .
1:0	Reserved.

PMx6A AcpiSmiCmd

Bits	Description
15:0	AcpiSmiCmd . Read-write. ColdReset: 00B0h. These bits define the 16-bit IO base address[15:0] of the ACPI SMI command block defined in 3.26.15.7 [SmiCmdBlk] . The address is required to be WORD-aligned (Addr[0]=0).

PMx6E AcpiPm2CntBlk

Bits	Description
15:0	AcpiPm2CntBlk . Read-write. Cold reset: 0. These bits define the 16-bit IO base address[15:0] of the ACPI power management additional control block defined in 3.26.15.3 [AcpiPm2CntBlk] .

PMx74 AcpiConfig

Bits	Description
31:30	Reserved.
29	RtcWakeAlarm . Read-write. Cold Reset: 0. 0=Use IO073_x0C[IRQF] as one of the system wake-up event if IRQF is enabled. 1=Use IO073_x0C[AF] as one of the system wake-up event if AF is enabled.
28	PcieGeventMap . Read-write. Cold reset: 1. 1=Route PME message from NB to GEvent 24, hot plug message from APU to GEvent 7.
27	WakePinAsGevent . Read-write. Cold reset: 0. 1=Treat Wake# pin as GEvent input.
26	Reserved.
25	PcieWakMask . Read-write. Cold reset: 0. 1=Disable the PCIE_WAK_STS and PCIE_WAK_DIS function defined in AcpiPmEvtBlkx00[PciExpWakeStatus] and AcpiPmEvtBlkx02[PciExpWakeDis] .
24	PcieNative . Read-write. Cold reset: 0. 1=Block PCIe GPP PME message and hot plug message from generating SCI.
23:10	Reserved.
9	AcpiReducedHwEn . Read-write. Reset: 0. 0=ACPI fixed register interface is enabled. 1=The decoding of ACPI fixed registers and SCI are disabled; In addition wake function from AcpiPmEvtBlk is disabled as well.
8	PwnBtnEn . Read-write. Reset: 1. 1=Enable power button support in AcpiPmEvtBlk block.
7	BiosRls . RAZ; write-1-only. Cold reset: 0. Writing 1 to this bit generates SMI, NMI or IRQ13 depending on SMIxB0[Smicontrol73] .

6	MaskArbDis. Read-write. Cold reset: 1.
5	Reserved.
4	TmrEnEn. Read-write. Cold reset: 0. 1=Enable the TMR_EN function defined in AcpiPmEvtBlkx02 [TmrEn].
3	Reserved.
2	RtcEnEn. Read-write. Cold reset: 0. 1=Enable the RTC_EN function defined in AcpiPmEvtBlkx02 [RtcEn].
1	GblEnEn. Read-write. Cold reset: 0. 1=Enable the GBL_EN function defined in AcpiPmEvtBlkx02 [GblEn].
0	DecEnAcpi. Read-write. Cold reset: 0. 1=Enable decoding of the standard ACPI registers.

PMx78 WakeIoAddr

Bits	Description
15:0	WakeIoBaseAddress. Read-write. Reset: FFFFh.

PMx7A HaltCountEn

Bits	Description
15	CountHaltMsgEn. Read-write. Reset: 0. 1=FCH keeps track of the APU state by counting HALT entering and exit messages; When the number of net HALT enter messages matches with NumOfHalt, FCH initiates C1e.
14:4	Reserved.
3:0	NumOfHalt. Read-write. Reset: 0. Defines the number of HALT messages to track before FCH should initiate C1e sequence.

PMx7C C1eWrPortAdr

Bits	Description
15:0	C1eWrPortAdr. Read-write. Reset: FFFFh.

PMx7E CStateEn

Bits	Description
15	MaskIntrEn. Read-write. Reset: 1. 1=APIC interrupts are deferred until the first ACPI access after the system resumes from S state; In addition, A20M, IGNNE, INTR, NMI, INIT messages are deferred the same way, but SMI is not be deferred. This is mainly to guard against unexpected interrupt being sent to OS during S1 resume.
14	MaskCStateSys. Read-write. Reset: 0. 1=Skip C state if there is a pending interrupt such as SMI, NMI, and INIT request.
13:8	Reserved.
7	CMsgMaskEn. Read-write. Reset: 1.

6	CPopUpEn. Read-write. Reset: 1. 1=Enable pop up capability, which means APU goes to C2 if there is a traffic and comes back to C3 after being idle for a while. This bit should be set to 0 when AltVid is not enabled.
5	C1eToC3En. Read-write. Reset: 1. 1=Put APU into C3 state in C1e state.
4	C1eToC2En. Read-write. Reset: 0. 1=Put APU into C2 state in C1e state.
3	C2EnhanceEn. Read-write. Reset: 0. 1=Enable C2 enhancement.
2	C2ToC3Enable. Read-write. Reset: 0. 1=Put APU into C3 even in the case of IO reads to CpuCntBlkx04 [PLv12] .
1:0	C1eWrPortSel. Read-write. Reset: 00b.

PMx80 Break Event

Bits	Description
31	Reserved.
30:24	AutoStutterLimit. Read-write. Cold reset: 0. This specifies the limit for the AutoStutterTimer. Time unit is defined by [AutoStutterTimeSel] . See [AutoStutterTimerEn] for detailed description on AutoStutterTimer.
23:22	Reserved.
21	UsbPeriodicalSetBmSts. Read-write. Cold reset: 1. 1=Treat USB isochronous traffic as source of DMA traffic.
20:19	Reserved.
18	Usb20SetBmSts. Read-write. Cold reset: 1. 1=Treat USB 2.0 traffic as source of DMA traffic.
17:14	Reserved.
13	ServerCEn. Read-write. Cold reset: 0. 1=FCH monitors the HALT messages coming from APU(s). When all APUs are in HALT state, FCH automatically transitions to C3/C1e state. If any APU exits from HALT state, FCH will exit out from C3/C1e state as well. This is used in conjunction with PMx7A .
12	AutoStutterTimeSel. Read-write. Cold reset: 0. This bit selects the time increment used by the AutoStutterTimer. 0=2 us increment. 1=1 ms increment.
11	AutoStutterTimerEn. Read-write. Cold reset: 0. 1=Enable an AutoStutterTimer that automatically counts whenever LDTSTOP is asserted during C3/C1e state. When the timer reaches the threshold defined by AutoStutterLimit, it will stutter the C state machine. This feature is specifically designed to periodically reconnect the HT link in the case of a long idle time for multi-CPU.
10	MergeBMReqEn. Read-write. Cold reset: 0. 1=The logic merges BMREQ# and AllowLdtStop together internally.
9	BusReqHoldEn. Read-write. Cold reset: 0. 1=Extend BMREQ# until LDTSTP# is asserted.
8	BmReqPopUpEn. Read-write. Cold reset: 0. 1=Allow PopUp if BMREQ# is toggled when PopUp function is enabled.
7	BmReqEn. Read-write. Cold reset: 0. 1=Treat BMREQ# as one source of Break Event.
6	Reserved.
5	EffMaskEn. Read-write. Cold Reset: 0.
4	EnableBreak. Read-write. Cold reset: 0. 1=Skip the C state transition if there is break event when entering C state.

3	MaskNbBmStsSet. Read-write. Reset: 0.
2	AutoClrBmSts. Read-write. Cold reset: 0. It is used for PopUp and C1e function. 1=Automatically clear AcpiPmEvtBlkx00[BmStatus] before entering C1e state.
1	AutoBmRld. Read-write. Cold reset: 0. 1=Generate an internal AcpiPmEvtBlkx00[BmStatus] enable bit (that is similar to AcpiPm1CntBlkx00[BmRld]) upon entry to C1e. Depending on the configuration of other bits, bus master activity or IDLE_EXIT# pin could cause FCH to break out from C1e.
0	BmStsRdMask. Read-write. Cold reset: 0. 0= AcpiPmEvtBlkx00[BmStatus] is set to 1 if there is any DMA traffic in FCH. 1=Make AcpiPmEvtBlkx00[BmStatus] always return 0 except for USB 1.1 traffic.

PMx88 CStateControl

Bits	Description
31:14	Reserved.
13	LdtStpCmd. Read-write. Reset: 0. Programming it to 1 from 0 forces FCH to toggle LDTSTP#.
12	StutterMode. Read-write. Reset: 0. 1=Enable stutter mode.
11	NoChkAgpBusyEnB. Read-write. Reset: 0.
10:9	Reserved.
8	AgpStpEn. Read-write. Reset: 0.
7:6	Reserved.
5	SlpEn. Read-write. Reset: 0. 1=Enable LDTSTOP# as an output.
4	CcEn. Read-write. Reset: 0. 1=Enable C State. This bit must be set in order to exercise C state.
3	Reserved.
2	DlySlpEn. Read-write. Reset: 0. 1=Delay recognition of STPGNT# until there is no pending read in AB.
1	Reserved.
0	WaitStpGntEnB. Read-write. Reset: 0. 1=Wait for STPGNT# in ACPI S state.

PMx8E PopUpEndTime

Bits	Description
7:0	PopUpEndTime. Read-write. Cold reset: 80h.

PMx94 CStateTiming0

Bits	Description												
31:26	Reserved.												
25:24	LdtEndTime. Read-write. Cold reset: 0. Specifies the delay from deassertion of LDTSTP# till the deassertion of STPCLK. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>0 us</td><td>10b</td><td>32 us</td></tr><tr><td>01b</td><td>1 us</td><td>11b</td><td>64 us</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	0 us	10b	32 us	01b	1 us	11b	64 us
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>										
00b	0 us	10b	32 us										
01b	1 us	11b	64 us										

23:16	LdtStartTime . Read-write. Cold reset: 10h. Specifies the LDTSTP# deassertion time in 1 us increments in C state.
15:8	SLdtStartTime . Read-write. Cold reset: 0. Specifies the delay between LPC_PD# assertion and LDTSTP# assertion when the system enters ACPI S states. The time is in 1 us increments, with 1 us uncertainty.
7:0	StutterTime . Read-write. Cold reset: 1. Specifies the LDTSTP# duration in 1 us increments. This is basically the minimum LDTSTP# assertion time.

PMx98 CStateTiming1

Bits	Description			
31	Reserved.			
30:28	VidFidTime. Read-write. Cold reset: 0. Specifies the VID/FID LDTSTP# duration.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	0 us	100b	16 us
	001b	2 us	101b	32 us
	010b	4 us	110b	64 us
	011b	8 us	111b	128 us
27:26	Reserved.			
25:24	AgpEndTime. Read-write. Cold reset: 01b.			
23:16	Reserved.			
15:8	FirstLdtStartTime. Read-write. Cold reset: 10h. Specifies the very first LDTSTP# assertion delay in 1 us increments from reception of STPGNT.			
7:0	StpClkDlyTime. Read-write. Cold reset: 0. Specifies the additional STPCLK# deassertion delay in number of oscillator clocks for S1 resume.			

PMx9C C2Count

Bits	Description
7:0	C2Count . Read-only; updated-by-hardware. Reset: 0. Specifies the amount of time the APU spends in STPGNT state (but LDTSTOP# is not asserted) during C1e. Each increment is approximately 0.39% (1/256). This field is updated every second.

PMx9D C3Count

Bits	Description
7:0	C3Count . Read-only; updated-by-hardware. Reset: 0. Specifies the amount of time LDTSTOP# is asserted during C1e. Each increment is approximately 0.39% (1/256). This field is updated every second.

PMxA0 MessageCState

Bits	Description												
31	CheckCoreIdDis. Read-write. Reset: 0. 1=Ignore core ID check if (MultiCoreEn == 1). 0=Enable core ID check if (MultiCoreEn == 1).												
30:24	ExtendValue. Read-write. Reset: 0. Specifies the timer value to be used with ExtendEnable. The value is the number of 66 MHz clocks.												
23	MultiCoreEn. Read-write. Reset: 0. 1=C state control logic inside FCH assumes multi-core configuration; PMx7A [NumOfHalt] should be programmed accordingly; FCH keeps track of APU C state by monitoring each core's C state message instead of package state.												
22	FusionExitCMsgDis. Read-write. Reset: 0. 1=ExitC Message will be blocked.												
21	FusionAllowCMsgDis. Read-write. Reset: 0. 1=AllowC Message will be blocked.												
20:16	<p>TmrSelOverride. Read-write. Reset: 0. These bits are used with TimerTickChgMsgEn. In case that FCH auto-timer detection logic doesn't function properly, these bits can be used to override the logic and force the logic to monitor the specific timer.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[4]</td><td>1=Force the logic to monitor HPET timer 2 if HPET is selected</td></tr> <tr> <td>[3]</td><td>1=Force the logic to monitor HPET timer 1 if HPET is selected</td></tr> <tr> <td>[2]</td><td>1=Force the logic to monitor HPET timer 0 if HPET is selected</td></tr> <tr> <td>[1]</td><td>1=Use RTC</td></tr> <tr> <td>[0]</td><td>1=Use HPET</td></tr> </table>	Bit	Definition	[4]	1=Force the logic to monitor HPET timer 2 if HPET is selected	[3]	1=Force the logic to monitor HPET timer 1 if HPET is selected	[2]	1=Force the logic to monitor HPET timer 0 if HPET is selected	[1]	1=Use RTC	[0]	1=Use HPET
Bit	Definition												
[4]	1=Force the logic to monitor HPET timer 2 if HPET is selected												
[3]	1=Force the logic to monitor HPET timer 1 if HPET is selected												
[2]	1=Force the logic to monitor HPET timer 0 if HPET is selected												
[1]	1=Use RTC												
[0]	1=Use HPET												
15:14	<p>UsbEhciModeFusion[1:0]. Read-write. Reset: 0. These bits are used with Fusion CPU C state.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[1]</td><td>1=FCH causes CPU to break out from C state when USB EHCI has pending traffic.</td></tr> <tr> <td>[0]</td><td>1=FCH stutters the CPU C state whenever USB EHCI has pending traffic.</td></tr> </table>	Bit	Definition	[1]	1=FCH causes CPU to break out from C state when USB EHCI has pending traffic.	[0]	1=FCH stutters the CPU C state whenever USB EHCI has pending traffic.						
Bit	Definition												
[1]	1=FCH causes CPU to break out from C state when USB EHCI has pending traffic.												
[0]	1=FCH stutters the CPU C state whenever USB EHCI has pending traffic.												
13:12	<p>UsbOhciModeFusion[1:0]. Read-write. Reset: 0. These bits are used with Fusion CPU C state.</p> <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[1]</td><td>1=FCH causes CPU to break out from C state when USB OHCI has pending traffic.</td></tr> <tr> <td>[0]</td><td>1=FCH stutters the CPU C state whenever USB OHCI has pending traffic.</td></tr> </table>	Bit	Definition	[1]	1=FCH causes CPU to break out from C state when USB OHCI has pending traffic.	[0]	1=FCH stutters the CPU C state whenever USB OHCI has pending traffic.						
Bit	Definition												
[1]	1=FCH causes CPU to break out from C state when USB OHCI has pending traffic.												
[0]	1=FCH stutters the CPU C state whenever USB OHCI has pending traffic.												
11	ExtendEnable. Read-write. Reset: 0. 1=Enable FCH to start a timer whenever the C state is exited, in order to prevent CPU from going back to C state before the timer expires. See ExtendValue for the timer.												
10	ClkIntrTagEn. Read-write. Reset: 0. 1=Enable FCH to mark the periodic timer interrupt.												
9	PopUpByEc. Read-write. Reset: 0. A static bit that can be written by IMC to cause FCH to pop up C state message to CPU.												
8	WakeByEc. Read-write. Reset: 0. A static bit that can be written by IMC to cause FCH to generate C state exit message to CPU.												
7	SelfExitEnable. Read-write. Reset: 0. 1=FCH exits to C0 state from non-C0 state when there is a break event, and exits to C1 state from non-C0 state when there is traffic.												
6	BatteryModeEn. Read-write. Reset: 0. 1=A change in power mode (battery vs AC) causes FCH to tell CPU to exit from C state.												
5	Reserved.												

4	FusionSerrEn. Read-write. Reset: 0. 1=FCH C state coordination logic causes CPU to exit from C state when there is a system error within the FCH.
3	FusionPerrEn. Read-write. Reset: 0. 1=FCH C state coordination logic causes CPU to exit from C state when there is a parity error within the FCH.
2	FusionCEnable. Read-write. Reset: 1=Enable the FCH Fusion C state coordination logic. Fusion CPU contains the actual C state logic and FCH contains the coordination logic which sends handshake message to CPU to help it to decide which C state to go into.
1	TimerTickChgMsgEn. Read-write. Reset: 0. 1=FCH sends a message to APU indicating the latest periodic timer interval. FCH automatically determines which timer (PIT, RTC, or HPET) is being used. See TmrSelOverride.
0	BattModeChgMsgEn. Read-write. Reset: 0. 1=FCH automatically sends a message to CPU indicating the power mode (AC vs battery); In addition, every time it is changed, FCH generates a message to indicate the update.

PMxB0 DeferTimeTick

Bits	Description																				
31:12	Reserved.																				
11	Reserved.																				
10:8	DeferTimerTickValue. Read-write. Reset: 0. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>No skipping</td><td>100b</td><td>Skip 4 timer ticks</td></tr><tr><td>001b</td><td>Skip 1 timer tick</td><td>101b</td><td>Skip 5 timer ticks</td></tr><tr><td>010b</td><td>Skip 2 timer ticks</td><td>110b</td><td>Skip 6 timer ticks</td></tr><tr><td>011b</td><td>Skip 3 timer ticks</td><td>111b</td><td>Skip 7 timer ticks</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	No skipping	100b	Skip 4 timer ticks	001b	Skip 1 timer tick	101b	Skip 5 timer ticks	010b	Skip 2 timer ticks	110b	Skip 6 timer ticks	011b	Skip 3 timer ticks	111b	Skip 7 timer ticks
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	No skipping	100b	Skip 4 timer ticks																		
001b	Skip 1 timer tick	101b	Skip 5 timer ticks																		
010b	Skip 2 timer ticks	110b	Skip 6 timer ticks																		
011b	Skip 3 timer ticks	111b	Skip 7 timer ticks																		
7:2	Reserved.																				
1	ForceTmrTickEn. Read-write. Reset: 0. 1=If (DeferTimerTickEn == 1) && FCH has skipped a timer tick interrupt, FCH immediately generates the timer tick interrupt upon C state exit.																				
0	DeferTimerTickEn. Read-write. Reset: 0. 1=FCH skips a number of timer tick interrupts based on the value defined in DeterTimeTickValue when CPU is in C state. When CPU is not in C state, FCH does not skip any timer tick interrupt.																				

PMxB4 Tpreset1b

Bits	Description
31:30	Reserved.
29:24	Tpreset1b. Read-write. Cold reset: 5h. This is the timing parameter used for S*->S0 state transition. It specifies the delay between CPU_STP# de-assertion and LPC_PD# de-assertion, in 8 us increment with 8 us uncertainty.
23:12	Reserved.

11:9	FidVidOption. Read-write. Cold reset: 0. Specifies the additional FID/VID exit delay.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	0 ns	100b	490 ns
	001b	140 ns	101b	560 ns
	010b	210 ns	110b	350 ns
	011b	280 ns	111b	420 ns
8	DelayLdtStp. Read-write. Cold reset: 0. 1=Enable LDTSTP# assertion time.			
7:1	Reserved.			
0	FidProtectEn. Read-write. Cold reset: 0. 1=Skip C-state transition when FID/VID messages are received concurrently.			

PMxB8 Tpreset2

Bits	Description										
7:6	ClkGateCntrl. Read-write. Cold reset: 2h. These two bits control whether SMBUS module allows clock gating to the internal 66 MHz core clock.										
	<table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable the clock gating function</td></tr> <tr> <td>01b</td><td>Wait 16 clocks before allowing clock gating to the SMBUS module</td></tr> <tr> <td>10b</td><td>Wait 64 clocks before allowing clock gating to the SMBUS module</td></tr> <tr> <td>11b</td><td>Wait 256 clocks before allowing clock gating to the SMBUS module</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable the clock gating function	01b	Wait 16 clocks before allowing clock gating to the SMBUS module	10b	Wait 64 clocks before allowing clock gating to the SMBUS module	11b	Wait 256 clocks before allowing clock gating to the SMBUS module
<u>Bits</u>	<u>Definition</u>										
00b	Disable the clock gating function										
01b	Wait 16 clocks before allowing clock gating to the SMBUS module										
10b	Wait 64 clocks before allowing clock gating to the SMBUS module										
11b	Wait 256 clocks before allowing clock gating to the SMBUS module										
5:0	Tpreset2. Read-write. Cold reset: 8h. This is the timing parameter used for S*->S0 state transitions. It specifies the LDTSTP# deassertion delay in 8 us increment with 8 us uncertainty.										

PMxB9 LpcMisc

Bits	Description
7	Reserved.
6	Reserved.
5	Reserved.
4	Reserved.
3	ClkRunDisable. Read-write. Cold reset: 0. Legacy DMA and serial IRQ logic reside in this module and they are running on the 33 MHz LPCCLK. 1=Disable this module's ability to support CLKRUN# function from PCIBridge; In other words, this module prevents PCIBridge from stopping the 33 MHz clock.
2:0	Reserved.

PMxBA S_StateControl

Bits	Description
15	MaskPmeMsgEn. Read-write. Cold reset: 0. 1=If (PmeMsgEn == 1), PmeAck messages are ignored and ACPI S state logic solely uses the timeout mechanism to sequence through the S3 state.
14	WakePinEnable. Read-write. Cold reset: 0. 1=Enable wake up from WAKE# pin.

13	Reserved.
12:6	Reserved.
5	Reserved.
4	PmeMsgTrig . Read-write. Reset: 0. IF (WRITE) THEN Software writes this bit to trigger a PmeTurnOff sequence to NB. IF (READ) THEN Reading this bit returns the status of the PmeTurnOff sequence. 1=Not done. 0=Done.
3	PmeMsgEn . Read-write. Cold reset: 0. 1=Enable PmeTurnOff/PmeMsgAck handshake.
2	Reserved.
1	Reserved.
0	LongSLPS3 . Read-write. Cold reset: 0. 1=Extend SLP_S3# assertion to 1 s minimum.

PMxBC ThrottlingControl

Bits	Description																				
15	Therm2SecDelay . Read-write. Cold reset: 0. 1=Enable 2 second delay for thermal clock throttle. This bit affects both hardware and software throttle.																				
14	NoWaitStpGntEn . Read-write. Cold reset: 0. 0=Wait for STPGNT after asserting STPCLK. 1=Do not wait for STPGNT after asserting STPCLK. This bit affects both hardware and software throttle.																				
13	ThermThrotPeriod . Read-write. Cold reset: 0. Specifies the clock throttle period for hardware thermal throttle. 0=30 us. 1=244 us.																				
12:8	Reserved.																				
7	ThrottleControl[3] . Read-write. Cold reset: 0. 1=Enable hardware thermal clock throttle.																				
6:4	ThrottleControl[2:0] . Read-write. Cold reset: 0. Specifies the throttle interval for STPCLK de-assertion in hardware thermal clock throttle: <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>000b</td><td>50%</td><td>100b</td><td>50%</td></tr><tr><td>001b</td><td>12.5%</td><td>101b</td><td>62.5%</td></tr><tr><td>010b</td><td>25%</td><td>110b</td><td>75%</td></tr><tr><td>011b</td><td>37.5%</td><td>111b</td><td>87.5%</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	000b	50%	100b	50%	001b	12.5%	101b	62.5%	010b	25%	110b	75%	011b	37.5%	111b	87.5%
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
000b	50%	100b	50%																		
001b	12.5%	101b	62.5%																		
010b	25%	110b	75%																		
011b	37.5%	111b	87.5%																		
3:2	Reserved.																				
1:0	AcpiThrotPeriod . Read-write. Cold reset: 0. Specifies the clock throttle period for software thermal throttle. See CpuCntBlkx00 [ClkValue] for software thermal throttle. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>15 us</td><td>10b</td><td>244 us</td></tr><tr><td>01b</td><td>30 us</td><td>11b</td><td>Reserved</td></tr></table>	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>	00b	15 us	10b	244 us	01b	30 us	11b	Reserved								
<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>																		
00b	15 us	10b	244 us																		
01b	30 us	11b	Reserved																		

PMxBE ResetControl1**Table 266: BIOS Recommendations for KbRstEn**

Case	Condition	Setting	Comments
1	If the KBRST# / GEVENT1# I/O pin is not connected to system keyboard reset or is configured as GEvent1 function.	0	This bit must be cleared by the platform system BIOS in this case.
2	All other situations other than that specified in Case 1	Do not program.	Value should remain at power-up default setting.

Bits	Description										
7	RstToCpuPwrGdEn. Read-write. Cold reset: 0. 1=FCH toggles CpuPwrGd on every reset.										
6	HwmResetOption. Read-write. Cold reset: 1. 0=Hwm function defined at 3.26.14 [Power Management Block 2 (PM2) Registers] is reset by RsmRst. 1=Hwm function defined at 3.26.14 [Power Management Block 2 (PM2) Registers] is reset by PciRst.										
5	SlpTypeControl. Read-write. Cold reset: 1. 1=Enable the function of AcpiPm1CntBlkx00[SlpTypeEn]. 0=AcpiPm1CntBlkx00[SlpTypeEn] bit has no effect.										
4	KbRstEn. Read-write. Cold reset: 1. BIOS: See Table 266. 1= Enable KBRST# pin to trigger keyboard reset.										
3:2	CpuRstControl. Read-write. Cold reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>CpuReset is deasserted after PciReset</td></tr> <tr> <td>01b</td><td>CpuReset is deasserted as PciReset</td></tr> <tr> <td>10b</td><td>CpuReset is deasserted before PciReset</td></tr> <tr> <td>11b</td><td>CpuReset is deasserted after PciReset</td></tr> </table>	Bits	Definition	00b	CpuReset is deasserted after PciReset	01b	CpuReset is deasserted as PciReset	10b	CpuReset is deasserted before PciReset	11b	CpuReset is deasserted after PciReset
Bits	Definition										
00b	CpuReset is deasserted after PciReset										
01b	CpuReset is deasserted as PciReset										
10b	CpuReset is deasserted before PciReset										
11b	CpuReset is deasserted after PciReset										
1	KbPciRstEn. Read-write. Cold reset: 1. This bit must not be programmed by the BIOS. It should be left with the power up default value of 1. 1=Make PCI reset during keyboard reset, which can be triggered by KBRST# pin or IMC.										
0	SoftResetEn. Read-write. Cold reset: 0. 1=Block any reset request until the system is not in C state.										

PMxC0 S5/Reset Status

This register shows the source of previous reset.

Bits	Description
31:30	Reserved.
29	EcWatchdogRst. Write-1-to-clear; Read. Cold reset: 0.
28	HangReset. Write-1-to-clear; Read. Cold reset: 0.
27	SyncFlood. Write-1-to-clear; Read. Cold reset: 0.
26	RemoteResetFromASF. Write-1-to-clear; Read. Cold reset: 0.
25	WatchdogIssueReset. Write-1-to-clear; Read. Cold reset: 0.
24	FailBootRst. Write-1-to-clear; Read. Cold reset: 0.
23	LtReset. Write-1-to-clear; Read. Cold reset: 0.

22	KbReset. Write-1-to-clear; Read. Cold reset: 0.										
21	SleepReset. Write-1-to-clear; Read. Cold reset: 0.										
20	DoFullReset. Write-1-to-clear; Read. Cold reset: 0.										
19	DoReset. Write-1-to-clear; Read. Cold reset: 0.										
18	DoInit. Write-1-to-clear; Read. Cold reset: 0.										
17	SoftPciRst. Write-1-to-clear; Read. Cold reset: 0.										
16	UserRst. Write-1-to-clear; Read. Cold reset: 0.										
15:14	PmeTurnOffTime. Read-write. Cold reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>1 ms</td></tr> <tr> <td>01b</td><td>2 ms</td></tr> <tr> <td>10b</td><td>4 ms</td></tr> <tr> <td>11b</td><td>8 ms</td></tr> </table>	Bits	Definition	00b	1 ms	01b	2 ms	10b	4 ms	11b	8 ms
Bits	Definition										
00b	1 ms										
01b	2 ms										
10b	4 ms										
11b	8 ms										
13	DisSbToNbPG. Read-write. Cold reset: 0. 1=Disable NBPwrGood.										
12	DisableLdtPwrGood. Read-write. Cold reset: 0. This is a LdtPwrGood control bit. 1=Disable the LdtPwrGood assertion along with NBPwrGood.										
11	SlpS3ToLdtPwrGdEn. Read-write. Cold reset: 1. 1=De-assert LDT_PWRGD as long as SLP_S3# goes low.										
10	PwrGdDwnBeforeSlpS3. Read-write. Cold reset: 0. BIOS: 1. 1=Delay SLP_S3 by 64 us and also qualify the FCH PwrGood with SLP_S3; This allows internal logic to put signals into correct states before turning off the S0 power.										
9:6	Reserved.										
5	ShutDownFan0. Write-1-to-clear; Read. Cold reset: 0.										
4	RemotePowerDownFromASF. Write-1-to-clear; Read. Cold reset: 0.										
3	ThermalTripFromTemp. Write-1-to-clear; Read. Cold reset: 0.										
2	Shutdown. Write-1-to-clear; Read. Cold reset: 0.										
1	FourSecondPwrBtn. Write-1-to-clear; Read. Cold reset: 0.										
0	ThermalTrip. Write-1-to-clear; Read. Cold reset: 0.										

PMxC4 ResetCommand

Bits	Description
7	ResetEn. Read-write. Cold reset: 0. 0=Writing to bit Reset is not allowed. 1=Writing to bit Reset is allowed.
6	ResetAllAcpi. Write-1-only; cleared-by-hardware. Cold reset: 0. Writing 1 to this bit emulates a reset button event.
5	ResetButtonEn. Read-write. Cold reset: 1. 1=Enable ResetButton. Sys_Reset_L assertion will trigger reset. 0=Disable ResetButton. Set to 0b if the System_rst_L pin is not used or configured to Gevent19/gpio73 (function 1) in IOMUX 73h.
4	ResetPcie. Read-write. Cold reset: 0. 1=Reset the GPP ports. 0=Release the PCIe reset.
3	UsrRst2Pll. Read-write. Cold reset: 1. 1=Stop PLL when the reset button is pressed.

2	SelectDebug. Read-write. Cold reset: 0. 0=Select PMxC0 [S5/Reset Status] to be S5/Reset Status register. 1=Select PMxC0 [S5/Reset Status] to be a debug status register.
1	MemRstDisable. Read-write. Cold reset: 0. 1=The memory reset function at DDR_RST# pin is disabled.
0	Reset. Write-1-only; cleared-by-hardware. Cold reset: 0. Writing 1 to this bit causes a PCI reset. This bit is enabled by RestEn bit.

PMxC5 CF9 Shadow

Bits	Description
7:0	Alias of IOCF9 .

PMxC8 Misc

Bits	Description										
31:24	ClkIntrVectorOrd. Read-write. Cold reset: 0. Specifies the value used to identify the clock interrupt.										
23	Reserved.										
22	ClkIntrVectorOrdEn. Read-write. Cold reset: 0. 1=The system timer interrupt in the IOAPIC is tagged with a value defined by ClkIntrVectorOrd.										
21	Reserved.										
20	ProcHotStsEn. Read-write. Cold reset: 0. 1=Enable PROCHOT# to generate TwarnStatus SMI_x84[16] and thermal throttle.										
19	UseCpuRst. Read-write. Cold reset: 1. 0=System reset causes INIT# instead of CPURST#.										
18	UseBypassRom. Read-write. Cold reset: 0. 1=Override the ROM straps and use BypassRomSel to determine which type of ROM to use. This is for BIOS debugging purposes or for systems having multiple BIOSes on board.										
17:16	BypassRomSel. Read-write. Cold reset: 0. These two bits override the two ROM strap pins if [UseBypassRom] == 1. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>LPC ROM</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>SPI ROM</td></tr> </table>	Bits	Definition	00b	LPC ROM	01b	Reserved	10b	Reserved	11b	SPI ROM
Bits	Definition										
00b	LPC ROM										
01b	Reserved										
10b	Reserved										
11b	SPI ROM										
15	HideSmbus. Read-write. Cold reset: 0. 1=Hide the SMBus PCI configuration space and promote LPC bridge PCI configuration space to function 0.										
14	Reserved.										
13	IdChangeEn. Read-write. Cold reset: 0. 1=Allow the software to change D14F0x00[DeviceID] and D14F0x08[RevisionID] .										
12	S5ResetOverride. Read-write. Cold reset: 0. 1=Mask off internet PCI reset used in ACPI.										
11	WriteBackEnable. Read-write. Cold reset: 0. 1=The WakeOnRing status bit is written back to HD audio controller upon system power up.										
10	LlbEn. Read-write. Cold reset: 0. 1=LLB function is enabled and system won't wake up from ACPI S state until LLB# is de-asserted.										

9:8	TempPolarity. Read-write. Cold reset: 0. Temperature polarity control for THRMTRIP and TALERT respectively. 0=Active low. 1=Active high.
7	DisablePciRom. Read-write. Cold reset: 0. 1=Disable PCI from strap.
6	TwarnEn. Read-write. Cold reset: 0. 1=Enable TALERT# pin.
5	EPromDeSelect. Read-write. Cold reset: 0.
4	UseAcpiStraps. Read-write. Cold reset: 0.
3	TDeadEn. Read-write. Cold reset: 1. 1=GEVENT2 takes up the THRMTRIP function; When THRMTRIP pin is low and [TFatalEn] is set, hardware switches the system to S5 automatically.
2	TFatalEn. Read-write. Cold reset: 1. 1=Enable both the soft PciRst and the THRMTRIP function.
1	Reserved.
0	CpuIoPullDownDrvStrength. Read-write. Cold reset: 0. 1=The integrated pull-down drive strength of all CPU IOs are increased by 50%.

PMxCC IoDrvSth

Bits	Description
31:30	Reserved.
29:27	IoDrvSth_Misc. Read-write. Cold reset: 011b. IO drive strength for GA20, KBRST#, SERIRQ, and SATA_ACT# pads.
26:24	IoDrvSth_Gpio. Read-write. Cold reset: 011b. IO drive strength for GPIO3, and GPIO[48:52] pads.
23:21	IoDrvSth_Gpio. Read-write. Cold reset: 011b. IO drive strength for BMREQ#, GPIO[0, 2, 4, 5, 7, 8, 9, 13, 37, 38, 39, 40], GPOC[0, 1] pads.
20:18	IoDrvSth_Req. Read-write. Cold reset: 011b. IO drive strength for REQ[3:0]# when they are configured as GPIO.
17:15	Reserved.
14:12	IoDrvSth_LPC. Read-write. Cold reset: 011b. IO drive strength for LPC LAD, LFRAME# pads. The recommended setting for single load is 111b.
11:0	Reserved.

PMxD0 RstCntrl

Bits	Description
7:6	RstLengthSel. Read-write. Cold reset: 0. This field selects which register is defined at PMxD1 .
5:0	Reserved.

PMxD1 Reset Function

Address: [PMxD0](#)[RstLengthSel].

Bits	Description
7:0	RstFunctLength.

PMxD1_x0 RstLength

Bits	Description
7:0	RstLength . Read-write. Cold reset: F4h. Specifies the A_RST# length. The amount of reset time = $\text{RstLength} * 4096 * 69.84 \text{ ns}$.

PMxD1_x1 APURstLength

Bits	Description
7:0	APURstLength . Read-write. Cold reset: FBh. Specifies the APU_RST# length. The amount of reset time = $\text{ApuRstLength} * 4096 * 69.84 \text{ ns}$.

PMxD1_x3 APUPwrGdLength

Bits	Description
7:0	APUPwrGdLength . Read-write. Cold reset: EAh. Specifies the LdtPwrGd latency. The amount of delay = $\text{APUPwrGdLength} * 4096 * 69.84 \text{ ns}$.

PMxD2 Pmio

Bits	Description
7:6	Reserved.
5:4	LpcClkDrvSth . Read-write. Cold reset: 11b. Drive strength control for LpcClk[1:0] respectively. 0=Clock output is 4 mA. 1=Clock output is 8 mA.
3:0	Reserved.

PMxD3 ManualReset

Bits	Description
7	Reserved.
6	AssertSDRstB . Read-write. Cold reset: 1. 0=Assert the reset to SDIO controller.
5	AssertAzRstB . Read-write. Cold reset: 1. 0=Assert the reset to AZ controller.
4	AssertUsbRstB . Read-write. Cold reset: 1. 0=Assert the reset to USB controllers.
3	AssertSataRstB . Read-write. Cold reset: 1. 0=Assert the reset to SATA controller.
2	AssertPciRstB . Read-write. Cold reset: 1. 0=Assert PCIRST# low.
1	AssertARstB . Read-write. Cold reset: 1. 0=Assert A_RST# low.
0	AssertLdtRstB . Read-write. Cold reset: 1. 0=Assert LDT_RST# low.

PMxD6 IMC Gating

Bits	Description
15	ImcEnable . Read-write. Reset: 0. BIOS: See 2.17.8. 1=Enable IMC.
14:0	Reserved.

PMxD8 Eprom Index

Bits	Description
7:0	EpromIndex . Read-write. Cold reset: 0.

PMxD9 Eprom Data

Bits	Description
7:0	EpromData . Read-write. Cold reset: 0.

PMxDA SataConfig

Bits	Description										
15:8	Reserved.										
7:6	RefDivSel . Read-write. Cold reset: 00b. BIOS: See 2.17.3.5. This specifies the reference clock divider setting. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Divide by 1 (25 MHz or 48 MHz reference clock)</td></tr> <tr> <td>01b</td><td>Divide by 2</td></tr> <tr> <td>10b</td><td>Divide by 4 (100 MHz reference clock)</td></tr> <tr> <td>11b</td><td>Divide by 4 (100 MHz reference clock)</td></tr> </table>	Bits	Definition	00b	Divide by 1 (25 MHz or 48 MHz reference clock)	01b	Divide by 2	10b	Divide by 4 (100 MHz reference clock)	11b	Divide by 4 (100 MHz reference clock)
Bits	Definition										
00b	Divide by 1 (25 MHz or 48 MHz reference clock)										
01b	Divide by 2										
10b	Divide by 4 (100 MHz reference clock)										
11b	Divide by 4 (100 MHz reference clock)										
5:4	RefClkSel . Read-write. Cold reset: 01b. BIOS: See 2.17.3.5. This specifies the reference clock source selection for SATA PLL. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Reference clock from crystal oscillator via PAD_XTALI and PAD_XTALO</td></tr> <tr> <td>01b</td><td>Reference clock from internal clock through CP_PLL_REFCLK_P and CP_PLL_REFCLK_N via RDL</td></tr> <tr> <td>10b</td><td>Reserved.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>	Bits	Definition	00b	Reference clock from crystal oscillator via PAD_XTALI and PAD_XTALO	01b	Reference clock from internal clock through CP_PLL_REFCLK_P and CP_PLL_REFCLK_N via RDL	10b	Reserved.	11b	Reserved.
Bits	Definition										
00b	Reference clock from crystal oscillator via PAD_XTALI and PAD_XTALO										
01b	Reference clock from internal clock through CP_PLL_REFCLK_P and CP_PLL_REFCLK_N via RDL										
10b	Reserved.										
11b	Reserved.										
3	Reserved.										
2	SetMaxGen2 . Read-write. Cold reset: 0. 0=SATA controller operates in maximum Gen3 (6.0 Gb/s) speed. 1=SATA controller operates in maximum Gen2 (3.0 Gb/s) speed for reduced power consumption.										
1	Reserved.										
0	SataEnable . Read-write. Cold reset: 1. BIOS: 1. 0=SATA controller is disabled. 1=SATA controller is enabled. Whenever SATA controller is being enabled by programming this field from 0 to 1, a IOCF9 software reset is recommended to reset the controller to a proper operational state.										

PMxDC SataConfig2

Bits	Description
31:17	Reserved.
16	PIICalibEn : SATA PHY PLL calibration enable. Read-write. Reset: 0. BIOS: See 2.17.3.3 .
15:0	Reserved.

PMxE0 ABRegBar

Bits	Description
31:16	Reserved.
15:3	ABRegBar . Read-write. Cold reset: 0. BIOS: See 2.17.10 . IO Base address of AB Configuration Registers. See AB configuration registers defined in 3.26.2 [AB Configuration Registers] .
2:0	Reserved.

PMxE4 AB Misc Control

Bits	Description										
31:2	Reserved.										
1:0	BlinkControl . Read-write. Cold reset: 0. This field controls the BLINK pin behavior. BLINK pin can be used to control the on/off of a LED on the board. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disabled. BLINK pin can be controlled by GPIO logic if so configured.</td></tr> <tr> <td>01b</td><td>BLINK pin is repeatedly driven to low for 1 sec and then released for 3 sec.</td></tr> <tr> <td>10b</td><td>BLINK pin is repeatedly driven to low for 2 sec and then released for 2 sec.</td></tr> <tr> <td>11b</td><td>BLINK pin is always driven to low.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disabled. BLINK pin can be controlled by GPIO logic if so configured.	01b	BLINK pin is repeatedly driven to low for 1 sec and then released for 3 sec.	10b	BLINK pin is repeatedly driven to low for 2 sec and then released for 2 sec.	11b	BLINK pin is always driven to low.
<u>Bits</u>	<u>Definition</u>										
00b	Disabled. BLINK pin can be controlled by GPIO logic if so configured.										
01b	BLINK pin is repeatedly driven to low for 1 sec and then released for 3 sec.										
10b	BLINK pin is repeatedly driven to low for 2 sec and then released for 2 sec.										
11b	BLINK pin is always driven to low.										

PMxE8 SDFlashCntrl

Bits	Description
7:2	Reserved.
1	Reserved.
0	SDFlashEnable . Read-write. Cold reset: 0. 0=Disable SD flash controller. 1=Enable SD flash controller, and GPIO[73:80] become SD flash interface.

PMxEB AzEn

Bits	Description
7:2	Reserved.

1	AzNoSnoopEnable. Read-write. Cold reset: 0. 1=HD audio data transfer doesn't cause the AcpiPmEvtBlkx00[BmStatus] bit to be set nor to wake up the CPU from C3 state. Under current C1e implementation, there is no need to set this bit.
0	AzEnable. Read-write. Cold reset: 1. BIOS: 1. 0=Disable HD audio controller. 1=Enable HD audio controller.

PMxEC LpcGating

Bits	Description
7:3	Reserved.
2	AbNoBypassEn. Read-write. Cold reset: 0. BIOS: 1. 1=Tells the A-Link that the LPC cycle should not be bypassed when a retry has timed out.
1	LpcA20En. Read-write. Cold reset: 0. 1=Enable A20# input.
0	LpcEnable. Read-write. Cold reset: 1. 1=Enable LPC bridge.

PMxED USB Gating

Bits	Description
7:5	Reserved.
4	UsbSmiEn. Read-write. Cold reset: 0. 1=Enable SMI for USB legacy support.
3:2	Reserved.
1	UsbIrqEn. Read-write. Cold reset: 0. 1=Enable IRQ1/IRQ12 for USB legacy support.
0	Reserved.

PMxEF USB Enable

BIOS: See [2.17.2.4 \[Enabling the xHCI Controller\]](#).

Bits	Description
7	PortRoutingSelect. Read-write. Cold reset: 1. Specifies controller(s) for USB ports 8 and 9. 0=EHCI 3 and OHCI 3 controllers. 1=xHCI controller.
6	Reserved.
5	Usb3EhciEnable. Read-write. Cold reset: 1. 1=Enable EHCI 3 controller (device 16h, function 0).
4	Reserved.
3	Usb2EhciEnable. Read-write. Cold reset: 1. 1=Enable EHCI 2 controller (device 13h, function 0).
2	Reserved.
1	Usb1EhciEnable. Read-write. Cold reset: 1. 1=Enable EHCI 1 controller (device 12h, function 0).
0	Reserved.

PMxF0 USB Control**Table 267: BIOS Recommendations for UsbPhyS5PwrDwnEnable**

Option	Description	Setting	Comment
1	USB Wake from S5 not supported on the platform	1	When the USB power rails USB PHY PLL, USB PHY core power and USB PHY DLL are connected to S0-S3 power, set the bit to 1 to disable the USB S4/S5 wake up function
2	USB Wake from S5 supported on the platform	0	When the USB power rails USB PHY PLL, USB PHY core power and USB PHY DLL are connected to S5 power, set the bit to 0 to enable the USB S4/S5 wakeup function

Bits	Description																		
15	PmioEhciMemSlpDis. Read-write. Cold Reset: 0. 0=Enable EHCI memory sleep. 1=Disable EHCI memory sleep.																		
14:13	Reserved.																		
12	Usb2BtGlobalClkGateEn. Read-write. Cold reset: 1. 1=Enable USB2.0 B-Link Global Clock Gating.																		
11	Reserved.																		
10:8	UsbSleepCtrl. Read-write. Cold reset: 3h. Control on USB advanced asynchronous sleep function. Setting of 000b:100b are for the advanced asynchronous sleep. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Standard 10 us sleep</td></tr> <tr> <td>001b</td><td>Advanced sleep for up to 2 micro frames</td></tr> <tr> <td>010b</td><td>Advanced sleep for up to 4 micro frames</td></tr> <tr> <td>011b</td><td>Advanced sleep for up to 6 micro frames</td></tr> <tr> <td>100b</td><td>Advanced sleep for up to next micro frame</td></tr> <tr> <td>101b</td><td>Reserved</td></tr> <tr> <td>110b</td><td>Reserved</td></tr> <tr> <td>111b</td><td>If CPU is in C state and the controller has already exhausted the link list, it can simply stop the asynchronous packets until CPU resumes back to C0 state. In this case, the controller will resume back to its standard mode.</td></tr> </table>	Bits	Definition	000b	Standard 10 us sleep	001b	Advanced sleep for up to 2 micro frames	010b	Advanced sleep for up to 4 micro frames	011b	Advanced sleep for up to 6 micro frames	100b	Advanced sleep for up to next micro frame	101b	Reserved	110b	Reserved	111b	If CPU is in C state and the controller has already exhausted the link list, it can simply stop the asynchronous packets until CPU resumes back to C0 state. In this case, the controller will resume back to its standard mode.
Bits	Definition																		
000b	Standard 10 us sleep																		
001b	Advanced sleep for up to 2 micro frames																		
010b	Advanced sleep for up to 4 micro frames																		
011b	Advanced sleep for up to 6 micro frames																		
100b	Advanced sleep for up to next micro frame																		
101b	Reserved																		
110b	Reserved																		
111b	If CPU is in C state and the controller has already exhausted the link list, it can simply stop the asynchronous packets until CPU resumes back to C0 state. In this case, the controller will resume back to its standard mode.																		
7:6	Reserved.																		
5	Reserved.																		
4	Reserved.																		
3	UsbS5ResetEnable. Read-write. Cold reset: 1. 1=Enable USB reset on S4/S5 resume detection.																		
2	UsbKbResetEnable. Read-write. Cold reset: 1. BIOS: See 2.17.2.3. 1=Enable resetting USB on keyboard reset.																		
1	Reserved.																		
0	UsbPhyS5PwrDwnEnable. Read-write. Cold reset: 0. BIOS: See Table 267. 1=Enable S4/S5 USB PHY power down support and disable S4 USB wake up support. 0=Disable S4/S5 USB PHY power down support and enable S4 USB wakeup support. The bit has to be set to 0 to support S4 USB wake up.																		

3.26.14 Power Management Block 2 (PM2) Registers

PM2 register space is accessed through two methods:

- Indirect IO access through index/data address pair at [IOCD0 \[PM2_Index\]](#) and [IOCD1 \[PM2_Data\]](#). Software first programs the offset into the index register [IOCD0 \[PM2_Index\]](#) and then reads/writes to/from the data register [IOCD1 \[PM2_Data\]](#).
- Memory mapped access through the AcpiMmio region. The ACPI registers range from FED8_0000h+400h to FED8_0000h+4FFh. See [PMx04\[MmioEn\]](#) for details on the AcpiMmio region.

PM2x00 Fan0InputControl

Bits	Description										
7:4	Reserved.										
3	TwoRampAlgorithmEn. Read-write. Reset: 0. 1=The two ramp fan control algorithm is enabled. 0=Disabled.										
2:0	FanInputControl. Read-write. Reset: 101b. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>100b-000b</td><td>Reserved.</td></tr> <tr> <td>101b</td><td>FanOut0 is enabled and temperature input is from TempTsi.</td></tr> <tr> <td>110b</td><td>FanOut0 is enabled and temperature input is 0.</td></tr> <tr> <td>111b</td><td>FanOut0 is disabled.</td></tr> </table>	Bits	Definition	100b-000b	Reserved.	101b	FanOut0 is enabled and temperature input is from TempTsi.	110b	FanOut0 is enabled and temperature input is 0.	111b	FanOut0 is disabled.
Bits	Definition										
100b-000b	Reserved.										
101b	FanOut0 is enabled and temperature input is from TempTsi.										
110b	FanOut0 is enabled and temperature input is 0.										
111b	FanOut0 is disabled.										

PM2x01 Fan0Control

When [AutoMode] == 1, the active duty cycle is controlled by the hardware automatically.

- If ActualTemperature < LowTemp{[PM2x07](#), [PM2x06](#)}, DutyCycle = 0;
- If LowTemp{[PM2x07](#), [PM2x06](#)} <= ActualTemperature < MedTemp{[PM2x09](#), [PM2x08](#)}, DutyCycle = [PM2x03 \[LowDuty0\]](#).
- If MedTemp{[PM2x09](#), [PM2x08](#)} <= ActualTemperature < HighTemp{[PM2x0B](#), [PM2x0A](#)},
 - If [LinearMode] == 0, DutyCycle = [PM2x04 \[MedDuty0\]](#).
 - If [LinearMode] == 1, DutyCycle = ((ActualTemperature - LowTemp{[PM2x07](#), [PM2x06](#)}) * ([PM2x05](#)[Multiplier] + 1) >> [PM2x05](#)[DutySel]) + [PM2x03 \[LowDuty0\]](#).
- If ActualTemperature >= HighTemp{[PM2x0B](#), [PM2x0A](#)}, DutyCycle = 100%.

In Automode, hysteresis limit defined by [PM2x0C \[LinearRange0\]](#) is applied to keep the fan from oscillating erratically.

Bits	Description
7:3	LinearAdjust. Read-write. Reset: 0. Specifies the additional offset to effective duty cycle under Linear mode.
2	FanPolarity. Read-write. Reset: 0. 0=FanOut0 drives low. 1=FanOut0 drives high.
1	LinearMode. Read-write. Reset: 0. 0=Use step function. 1=Use Linear function. See above description for details.
0	AutoMode. Read-write. Reset: 0. 0=FanOut0 is controlled by PM2x03 [LowDuty0] . 1=FanOut0 is controlled by the temperature input. See the above description for details on AutoMode.

PM2x02 Fan0Freq

Bits	Description			
7:0	FanFreq. Read-write. Reset: 0. Normally, 4-wire fan runs at 25 kHz and 3-wire fan runs at 100 Hz. FanOut0 frequency is programmed as below:			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	00h	28.64 kHz	F9h	58 Hz
	01h	25.78 kHz	FAh	44 Hz
	02h	23.44 kHz	FBh	35 Hz
	03h	21.48 kHz	FCh	29 Hz
	04h	19.83 kHz	FDh	22 Hz
	05h	18.41 kHz	FEh	14 Hz
	F7h	100 Hz	FFh	11 Hz
	F8h	87 Hz	F6h-06h	1/(FanFreq*2048*15 ns)

PM2x03 LowDuty0

Bits	Description								
7:0	LowDuty0. Read-write. Reset: 0. Specifies Fan0 duty number if (LowTemp{PM2x07, PM2x06} <= temperature < MedTemp{PM2x09, PM2x08}). There are 256 time slots in one fan cycle. Duty number N represents the (N+1)th time slot. Fan actively spins in time slot 0~ slot N, and stops from slot (N+1) ~ slot 255. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Always stop</td></tr> <tr> <td>FEh-01h</td><td>Fan spins for time slots <= LowDuty, stops for time slots > LowDuty.</td></tr> <tr> <td>FFh</td><td>Full speed run</td></tr> </table>	Bits	Definition	00h	Always stop	FEh-01h	Fan spins for time slots <= LowDuty, stops for time slots > LowDuty.	FFh	Full speed run
Bits	Definition								
00h	Always stop								
FEh-01h	Fan spins for time slots <= LowDuty, stops for time slots > LowDuty.								
FFh	Full speed run								

PM2x04 MedDuty0

Bits	Description								
7:0	MedDuty. Read-write. Reset: 0. Specifies Fan0 duty number using step function if (Med-Temp{PM2x09, PM2x08} <= temperature <= HighTemp{PM2x0B, PM2x0A}). There are 256 time slots in one fan cycle. Duty number N represents the (N+1)th time slot. Fan actively spins in time slot 0 ~ slot N, and stops from slot (N+1) ~ slot 255. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Always stop</td></tr> <tr> <td>FEh-01h</td><td>Fan spins for time slots <= MedDuty, stops for time slots > MedDuty.</td></tr> <tr> <td>FFh</td><td>Full speed run</td></tr> </table>	Bits	Definition	00h	Always stop	FEh-01h	Fan spins for time slots <= MedDuty, stops for time slots > MedDuty.	FFh	Full speed run
Bits	Definition								
00h	Always stop								
FEh-01h	Fan spins for time slots <= MedDuty, stops for time slots > MedDuty.								
FFh	Full speed run								

PM2x05 Multiplier0

When (PM2x01[AutoMode] == 1) && (PM2x00[TwoRampAlgorithm] == 1), Fan0 is in TwoRamp mode. The slope value of ramp1 and ramp0 is: Slope[7:0] = {PM2x05[DutySel], PM2x05[Multiplier]}. Slope[7:2] are the integer bits and Slope[1:0] are the fractional bits of the ramp slope.

BIOS has to calculate Slope[7:0] using the following equation:

$$\text{Slope} = (16'hFF00 - \{\text{LowDuty0}[7:0], 8'b0\}) / (\text{HighTemp0}[15:0] - \text{Hysteresis0}[15:0] - \text{MedTemp0}[15:0])$$

For example, if our setting is:

LowDuty0[7:0] = 25% = 40h

HighTemp0[15:0] = 90°C = 5A00h

MedTemp0[15:0] = 40°C = 2800h

Hysteresis0[15:0] = 10°C = 0A00h

Then:

Slope = (FF00h - 4000h) / (5A00h - 0A00h - 2800h) = 48896 / 10240 = 4.775

Convert the number 4.775 into our 8-bit format: 00010011b (13h). BIOS should program the Multiplier0 register as 13h in this example.

Bits	Description
7:6	DutySel. Read-write. Reset: 0. When Fan0 is programmed in AutoMode with linear function being selected, this field selects part of duty to be fed into fan as described in PM2x01 [Fan0Control] register description. When Fan0 is programmed in TwoRamp mode, this field specifies the upper 2 bits in Slope[7:0]. See the above register description for detail.
5:0	Multiplier. Read-write. Reset: 0. When Fan0 is programmed in AutoMode with linear function being selected, this field specifies the factor to calculate duty number as described in PM2x01 [Fan0Control] register description. When Fan0 is programmed in TwoRamp mode, this field specifies the lower 6 bits in Slope[7:0]. See the above register description for detail.

PM2x06 LowTemp0Lo

Bits	Description
7:0	LowTemp0[7:0]. Read-write. Reset: 0. Specifies the lower 8 bits of low temperature threshold.

PM2x07 LowTemp0Hi

Bits	Description
7:0	LowTemp0[15:8]. Read-write. Reset: 0. Specifies the higher 8 bits of low temperature threshold.

PM2x08 MedTemp0Lo

Bits	Description
7:0	MedTemp0[7:0]. Read-write. Reset: 0. Specifies the lower 8 bits of medium temperature threshold.

PM2x09 MedTemp0Hi

Bits	Description
7:0	MedTemp0[15:8]. Read-write. Reset: 0. Specifies the higher 8 bits of medium temperature threshold.

PM2x0A HighTemp0Lo

Bits	Description
7:0	HighTemp0[7:0]. Read-write. Reset: 0. Specifies the lower 8 bits of high temperature threshold.

PM2x0B HighTemp0Hi

Bits	Description
7:0	HighTemp0[15:8] . Read-write. Reset: 0. Specifies the higher 8 bits of high temperature threshold.

PM2x0C LinearRange0

Bits	Description
7:0	LinearRange . Read-write. Reset: 0. Specifies a variable range that Fan0 can tolerate. Fan0 is not affected if temperature varies within this range.

PM2x0D LinearHoldCount0

Bits	Description
7:0	LinearHoldCount . Read-write. Reset: 0. Specifies the fan cycles to be waited before duty cycle can be changed.

PM2x0E Fan0Hysteresis

Bits	Description
15:8	HysteresisHi . Read-write. Reset: 0. Specifies the hysteresis value (in temperature) of the Two Ramp Fan Control Algorithm. The unit is °C. See PM2x05 [Multiplier0] on how to program this register.
7:0	HysteresisLo . Read-write. Reset: 0. Reserved. This byte should always be programmed as 0.

PM2x50 Med2Temp0Lo

Bits	Description
7:0	Med2Temp0[7:0] . Read-write. Reset: 0. IF (PM2x00[TwoRampAlgorithmEn] ==1) THEN It specifies the lower byte of the temperature value of the turning point on the ramp. ELSE Unused. ENDIF.

PM2x51 Med2Temp0Hi

Bits	Description
7:0	Med2Temp0[15:8] . Read-write. Reset: 0. IF (PM2x00[TwoRampAlgorithmEn] ==1) THEN It specifies the higher byte of the temperature value of the turning point on the ramp. ELSE Unused. ENDIF.

PM2x52 Med2Duty0

Bits	Description
7:0	Med2Duty0[7:0] . Read-write. Reset: 0. IF (PM2x00[TwoRampAlgorithmEn] ==1) THEN It specifies the fan duty value of the turning point on the ramp. ELSE Unused. ENDIF.

PM2x53 Multiplier2_0

BIOS has to calculate Multiplier2_0[7:0] using the following equation:

$$\text{Multiplier2_0} = (\{\text{Med2Duty0}[7:0], 8'b0\} - \{\text{LowDuty0}[7:0], 8'b0\}) / (\text{Med2Temp0}[15:0] - \text{MedTemp0}[15:0])$$

For example, if our setting is:

PM2x52[Med2Duty0[7:0]]=50%=80h

PM2x03[LowDuty0[7:0]]=25%=40h

Med2Temp0[15:0]={PM2x51, PM2x50}=70°C=4600h

MedTemp0[15:0]={PM2x09, PM2x08}=40°C=2800h

Then:

$$\text{Multiplier2_0}[7:0] = (8000h - 4000h) / (4600h - 2800h) = 16384 / 7680 = 2.133$$

Convert the number 4.775 into our 8bit format: 00001000b (08h). BIOS should program Multiplier2_0 register as 08h in this example.

Bits	Description						
7:0	Multiplier2_0[7:0] . Read-write. Reset: 0. BIOS: See above description. IF (PM2x00[TwoRampAlgorithmEn]==1) THEN It specifies the slope value of ramp1lo and ramp0lo. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[1:0]</td><td>Integer bits of the ramp slope</td></tr> <tr> <td>[7:2]</td><td>Fractional bits of the ramp slope</td></tr> </table>	Bit	Definition	[1:0]	Integer bits of the ramp slope	[7:2]	Fractional bits of the ramp slope
Bit	Definition						
[1:0]	Integer bits of the ramp slope						
[7:2]	Fractional bits of the ramp slope						

PM2x60 FanStatus

Bits	Description
7:1	Reserved.
0	Fan0SpeedTooSlow . Read; write-1-to-clear. Reset: 0. 1=Fan0 runs slower than the value in the Fan0SpeedLimit{PM2x68, PM2x67}.

PM2x61 FanINTRouteLo

Bits	Description										
7:2	Reserved.										
1:0	Fan0INTRoute . Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>No SCI/SMI generated</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>SMI or SCI depending on GEVENT13 routing</td></tr> <tr> <td>11b</td><td>No SCI/SMI generated</td></tr> </table>	Bits	Definition	00b	No SCI/SMI generated	01b	SMI	10b	SMI or SCI depending on GEVENT13 routing	11b	No SCI/SMI generated
Bits	Definition										
00b	No SCI/SMI generated										
01b	SMI										
10b	SMI or SCI depending on GEVENT13 routing										
11b	No SCI/SMI generated										

PM2x63 SampleFreqDiv

Bits	Description
7:4	LinearRangeOutLimit[4:1] . Read-write. Reset:0. LinearRangeOutLimit[7:0] = {000b, LinearRangeOutLimit[4:1], 1b}. LinearRangeOutLimit specifies how close the fan duty follows the target duty cycle and is only used when the fan duty is changing. It is different from the PM2x0C [LinearRange0], which works like a hysteresis and used when fan duty is not changing.

3	Reserved.										
2	FanLinearEnhanceEn2 . Read-write. Reset: 0. 1=The positive hysteresis of fan duty is removed; PM2x0C [LinearRange0] only applies to the negative direction; As a result, the fan duty increases once the temperature is increased instead of waiting for a hysteresis.										
1:0	SampleFreqDiv . Read-write. Reset: 0. This field specifies the sampling rate of Fan Speed. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Base (22.5 kHz)</td></tr> <tr> <td>01b</td><td>Base (22.5 kHz) / 2</td></tr> <tr> <td>10b</td><td>Base (22.5 kHz) / 4</td></tr> <tr> <td>11b</td><td>Base (22.5 kHz) / 8</td></tr> </table>	Bits	Definition	00b	Base (22.5 kHz)	01b	Base (22.5 kHz) / 2	10b	Base (22.5 kHz) / 4	11b	Base (22.5 kHz) / 8
Bits	Definition										
00b	Base (22.5 kHz)										
01b	Base (22.5 kHz) / 2										
10b	Base (22.5 kHz) / 4										
11b	Base (22.5 kHz) / 8										

PM2x64 FanDebounceCounterLo

Bits	Description
7:0	FanDebounceCounter[7:0] . Read-write. Reset: 0. Specifies the lower 8 bits of the debounced counter when measuring fan speed.

PM2x65 FanDebounceCounterHi

Bits	Description
7:0	FanDebounceCounter[15:8] . Read-write. Reset: 0. Specifies the high 8 bits of the debounced counter when measuring fan speed.

PM2x66 Fan0DetectorControl

Bits	Description
7:5	Reserved.
4	ShutDownEnable . Read-write. Reset: 0. 1=The system will be shut down if PM2x60[Fan0SpeedTooSlow] remains 1 for more than 4 seconds.
3:2	Reserved.
1	UseAverage . Read-write. Reset: 0. 0=Do not to use average fan0 speed. 1=Use average fan0 speed.
0	FanDetectorEnable . Read-write. Reset: 0. 0=Disable fan0 speed measurement. 1=Enable fan0 speed measurement.

PM2x67 Fan0SpeedLimitLo

Bits	Description
7:0	FanSpeedLimit[7:0] . Read-write. Reset: 0. Specifies the lower 8 bits of Fan0SpeedLimit.

PM2x68 Fan0SpeedLimitHi

Bits	Description
7:0	FanSpeedLimit[15:8] . Read-write. Reset: 0. Specifies the higher 8 bits of Fan0SpeedLimit.

PM2x69 Fan0SpeedLo

Bits	Description
7:0	FanSpeed[7:0] . Read-only; updated-by-hardware. Reset: 0. Specifies the lower 8 bits of fan0 speed.

PM2x6A Fan0SpeedHi

Bits	Description
7:0	FanSpeed[15:8] . Read-only; updated-by-hardware. Reset: 0. Specifies the higher 8 bits of fan0 speed.

PM2x8A TempTsiLo

Bits	Description
7:0	TempTsi[7:0] . IF (PM2x8F [TempTsiWe] ==1) THEN Read-Write. ELSE Read-only; updated-by-hardware. ENDIF. Reset: 0. Specifies the lower 8 bits of TempTsi.

PM2x8B TempTsiHi

Bits	Description
7:0	TempTsi[15:8] . IF (PM2x8F [TempTsiWe] ==1) THEN Read-Write. ELSE Read-only; updated-by-hardware. ENDIF. Reset: 0. Specifies the higher 8 bits of TempTsi.

PM2x8C TempTsiLimitLo

Bits	Description
7:0	TempTsiLimit[7:0] . Read-write. Reset: 0. Specifies the lower 8 bits of TempTsiLimit.

PM2x8D TempTsiLimitHi

Bits	Description
7:0	TempTsiLimit[15:8] . Read-write. Reset: 0. Specifies the higher 8 bits of TempTsiLimit.

PM2x8E TempTsiChangeLimit

If (TempTsiChangeLimit != 0), filtering is applied to TempTsi{[PM2x8B \[TempTsiHi\]](#), [PM2x8A \[TempTsiLo\]](#)} as below:

- If $\text{TempTsi_New} > (\text{TempTsi_Old} + (\text{TempTsiChangeLimit} \ll 6))$, then
- If $\text{TempTsi_New} < (\text{TempTsi_Old} - (\text{TempTsiChangeLimit} \ll 6))$, then
- If $(\text{Temp_Old} - (\text{TempTsiChangLimit} \ll 6)) \leq \text{TempTsi_New} \leq (\text{TempTsi_Old} + (\text{TempChangeLimit} \ll 6))$, then

Bits	Description
7:0	TempTsiChangeLimit. Read-write. Reset: 0.

PM2x8F TempTsiWe

Bits	Description
7:6	Reserved.
5	TempTsiWe: TempTsi Write Enable. Read-write. Reset: 0. 0=TempTsi registers, PM2x8B [TempTsiHi] and PM2x8A [TempTsiLo] , are read-only and updated by hardware with the result from TempTsi sensor. 1=TempTsi registers are writable only by host and IMC; they are not updated by hardware with the result from the TempTsi sensor.
4:0	Reserved.

PM2x90 TempTsiStatus

Bits	Description
7:6	Reserved.
5	TempTsiStatus. Write-1-to-clear; Read. Reset: 0. 1=TempTsi{ PM2x8B [TempTsiHi] , PM2x8A [TempTsiLo] } is out of the limit.
4:0	Reserved.

PM2x92 TempTsiControl

Bits	Description										
7:4	Reserved.										
3:2	TempTsiControl. Read-write. Reset: 0. TempTsi sensor is enabled if $(\text{TempTsiControl} \neq 0)$. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Disable.</td></tr> <tr> <td>01b</td><td>If $(\text{TempTsi} > \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.</td></tr> <tr> <td>10b</td><td>If $(\text{TempTsi} < \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.</td></tr> <tr> <td>11b</td><td>If $((\text{TempTsiHi} > \text{TempTsiLimitLo}) \parallel (\text{TempTsiHi} < \text{TempTsiLimitHi}))$, then PM2x90[TempTsiStatus] = 1.</td></tr> </table>	Bits	Definition	00b	Disable.	01b	If $(\text{TempTsi} > \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.	10b	If $(\text{TempTsi} < \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.	11b	If $((\text{TempTsiHi} > \text{TempTsiLimitLo}) \parallel (\text{TempTsiHi} < \text{TempTsiLimitHi}))$, then PM2x90[TempTsiStatus] = 1.
Bits	Definition										
00b	Disable.										
01b	If $(\text{TempTsi} > \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.										
10b	If $(\text{TempTsi} < \text{TempTsiLimit})$, then PM2x90[TempTsiStatus] = 1.										
11b	If $((\text{TempTsiHi} > \text{TempTsiLimitLo}) \parallel (\text{TempTsiHi} < \text{TempTsiLimitHi}))$, then PM2x90[TempTsiStatus] = 1.										
1:0	Reserved.										

PM2x94 TempTsiINTRoute

Bits	Description										
7:4	Reserved.										
3:2	TempTsiINTRoute. Read-write. Reset: 0. <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>No SCI/SMI generated.</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>SMI or SCI according to GEVENT 13 INT routing.</td></tr> <tr> <td>11b</td><td>No SCI/SMI generated.</td></tr> </table>	Bits	Definition	00b	No SCI/SMI generated.	01b	SMI	10b	SMI or SCI according to GEVENT 13 INT routing.	11b	No SCI/SMI generated.
Bits	Definition										
00b	No SCI/SMI generated.										
01b	SMI										
10b	SMI or SCI according to GEVENT 13 INT routing.										
11b	No SCI/SMI generated.										
1:0	Reserved.										

PM2xDF TempTsiRstSel

Bits	Description
7:6	Reserved.
5	TempTsiRstSel. Read-write. Reset: 0. 1=Thermal diode monitoring function is not stopped by reset.
4:0	Reserved.

PM2xE0 AlertThermaltripStatus

Bits	Description
7:2	Reserved.
1	ThermalTripStatus. Read-only; updated-by-hardware. Reset: 0. 0=Current temperature is not above ThermalTripLimit. 1=Current temperature is above ThermalTripLimit.
0	AlertStatus. Read-only; updated-by-hardware. Reset: 0. 0=Current temperature is not above AlertLimit. 1=Current temperature is above AlertLimit.

PM2xE1 AlertLimitLo

Bits	Description
7:0	AlertLimit[7:0]. Read-write. Reset: 0.

PM2xE2 AlertLimitHi

Bits	Description
7:0	AlertLimit[15:8]. Read-write. Reset: 0.

PM2xE3 ThermalTripLimitLo

Bits	Description
7:0	ThermalTripLimit[7:0] . Read-write. Reset: 0.

PM2xE4 ThermalTripLimitHi

Bits	Description
7:0	ThermalTripLimit[15:8] . Read-write. Reset: 0.

PM2xE5 AlertThermaltripControl

Bits	Description								
7:5	TempSelAlert . Read-write. Reset: 0. This field selects which temperature sensor is the event source. It converts the selected Temp input pin into either TAlert or ThermalTrip function. <table> <tr> <th>Bits</th><th>Field Definition</th></tr> <tr> <td>100b-000b</td><td>Reserved</td></tr> <tr> <td>101b</td><td>TempTsi</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>	Bits	Field Definition	100b-000b	Reserved	101b	TempTsi	111b-110b	Reserved
Bits	Field Definition								
100b-000b	Reserved								
101b	TempTsi								
111b-110b	Reserved								
4:2	Reserved.								
1:0	AlertControl . Read-write. Reset: 0. <table> <tr> <th>Bit</th><th>Field Definition</th></tr> <tr> <td>[1]</td><td>Enable ThermalTrip on the selected Temp input</td></tr> <tr> <td>[0]</td><td>Enable TAlert on the selected Temp input</td></tr> </table>	Bit	Field Definition	[1]	Enable ThermalTrip on the selected Temp input	[0]	Enable TAlert on the selected Temp input		
Bit	Field Definition								
[1]	Enable ThermalTrip on the selected Temp input								
[0]	Enable TAlert on the selected Temp input								

3.26.15 Standard ACPI Registers

These are the standard registers defined by the ACPI specification. In order to access these ACPI registers, [PMx74](#)[DecEnAcpi] must be programmed to 1. ACPI registers are accessed through two methods:

- IO mapped access through base addresses defined by [PMx60](#) through [PMx6E](#).
- Memory mapped access through the AcpiMmio region. The ACPI registers range from FED8_0000h+800h to FED8_0000h+8FFh. See [PMx04](#)[MmioEn] for details on the AcpiMmio region.

3.26.15.1 AcpiPmEvtBlk

The IO mapped base address of this register block is defined by [PMx60](#).

AcpiPmEvtBlkx00 Pm1Status

Bits	Description
15	WakeStatus . Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=The system is in the sleep state and a wake-up event occurs.
14	PciExpWakeStatus . Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=The system wake is due to a PCI Express wakeup event.
13:11	Reserved.

10	RtcStatus. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=RTC generates an alarm. If both AcpiPmEvtBlkx02[RtcEn] and this bit are set to 1, a power management event: SCI, SMI, or resume event, is generated.
9	Reserved.
8	PwrBtnStatus. Read; set-by-hardware; write-1-to-clear. Reset: 0. Power button status bit. 1=The Power Button is pressed. In the system working state, if AcpiPmEvtBlkx02[PwrBtnEn] and this bit are both set to 1, an interrupt event is raised. In the sleeping or soft-off state, a wake event is generated when the power button is pressed regardless of the setting of AcpiPmEvtBlkx02[PwrBtnEn] .
7:6	Reserved.
5	GblStatus. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=An SCI is generated due to the BIOS wanting the attention of the SCI handler; Writing 1 to PMx74[BiosRls] sets this bit.
4	BmStatus. Read; set-by-hardware; write-1-to-clear. Reset: 0.
3:1	Reserved.
0	TmrStatus. Read; set-by-hardware; write-1-to-clear. Reset: 0. Timer carry status bit. 1=The 31st bit of the 32-bit counter changes from low to high or high to low. If both AcpiPmEvtBlkx02[TmrEn] and this bit are set to 1, an interrupt event is raised.

AcpiPmEvtBlkx02 Pm1Enable

Bits	Description
15	Reserved.
14	PciExpWakeDis. Read-write. Reset: 1. 1=Disable the inputs to AcpiPmEvtBlkx00[PciExpWakeStatus] from waking the system.
13:11	Reserved.
10	RtcEn. Read-write. Reset: 0. 1=A wake event is generated whenever AcpiPmEvtBlkx00[RtcStatus] is also set to 1.
9	Reserved.
8	PwrBtnEn. Read-write. Reset: 0. 1=A power management event (SCI or wake) is generated whenever AcpiPmEvtBlkx00[PwrBtnStatus] is also set to 1.
7:6	Reserved.
5	GblEn. Read-write. Reset: 0. 1=An SCI is raised whenever AcpiPmEvtBlkx00[GblStatus] is also set to 1.
4:1	Reserved.
0	TmrEn. Read-write. Reset: 0. This is the timer carry interrupt enable bit. 1=An SCI event is generated whenever the AcpiPmEvtBlkx00[TmrStatus] is set to 1. 0=No interrupt is generated when the AcpiPmEvtBlkx00[TmrStatus] bit is set to 1.

3.26.15.2 AcpiPm1CntBlk

The IO mapped base address of this register block is defined by [PMx62](#).

AcpiPm1CntBlkx00 PmControl

Bits	Description
15:14	Reserved.
13	SlpTypeEn. RAZ; write-1-only. Reset: 0. 1=The system sequences into the sleeping state defined by SlpTyp when PMxBE [SlpTypeControl] is set to 1.
12:10	SlpTyp. Read-write. Reset: 0. Specifies the sleep state the system enters if SlpTypeEn is set to 1. This design currently implements 5 states: S0, S1, S3, S4, and S5.
9:3	Reserved.
2	GblRIs. RAZ; write-only. Reset: 0. If SMIxB0 [17:16] is set to 01b, writing 1 to this bit generates SMI and sets SMIx88 [8].
1	BmRld. Read-write. Reset: 0.
0	SciEn. Read-write. Reset: 0. Selects the power management event to be either an SCI or SMI interrupt for the power management events. 1=Power management events generate SCI interrupts; 0=Power management events generate SMI interrupts.

3.26.15.3 AcpiPm2CntBlk

The IO mapped base address of this register block is defined by **PMx6E**.

AcpiPm2CntBlkx00 Pm2Control

Bits	Description
7:1	Reserved.
0	ArbDis. Read-write. Reset: 0.

3.26.15.4 AcpiPmTmrBlk

The IO mapped base address of this register block is defined by **PMx64**.

AcpiPmTmrBlkx00 TmrValue/ETmrValue

Bits	Description
31:0	TmrValue. Read-only. Reset: X. It returns the running count of the power management timer (ACPI timer).

3.26.15.5 CpuCntBlk

The IO mapped base address of this register block is defined by **PMx66**.

CpuCntBlkx00 ClkValue

Bits	Description
31:5	Reserved.
4	ThtEn. Read-write. Reset: 0. 1=Enable clock throttling as programmed in ClkValue.

3:1	ClkValue. Read-write. Reset: 0. Specifies the throttle interval for STPCLK in software clock throttling.			
	<u>Bits</u>	<u>Definition</u>	<u>Bits</u>	<u>Definition</u>
	000b	50%	100b	50%
	001b	12.5%	101b	62.5%
	010b	25%	110b	75%
	011b	37.5%	111b	87.5%
0	Reserved.			

CpuCntBlkx04 PLv12

Bits	Description
7:0	PLv12. RAZ; read-only. Reset: 0. Reads to this register return all zeros and generate an “enter C2” sequence to APU.

CpuCntBlkx05 PLv13

Bits	Description
7:0	PLv13. RAZ; read-only. Reset: 0. Reads to this register return all zeros and generate an “enter C3” sequence to APU.

3.26.15.6 AcpiGpe0Blk

The IO mapped base address of this register block is defined by [PMx68](#).

AcpiGpe0Blkx00 EventStatus

Bits	Description
31:0	EventStatus. Read; write-1-to-clear. Reset: X. Each bit represents an ACPI event status. For each bit, 1=The selected event input equals to the corresponding value in SMIx08 [SciTrig] . Configuration for the events are located at SMIx08 [SciTrig] through SMIx78 [SciMap14] . The status bits are also mirrored in SMIx00 [Event_Status] .

AcpiGpe0Blkx04 EventEnable

Bits	Description
31:0	EventEnable. Read-write. Reset: 0. Each bit controls whether ACPI should generate wakeup and SCI interrupt. The enable bits are also mirrored in SMIx04 [Event_Enable] .

3.26.15.7 SmiCmdBlk

The IO mapped base address of this register block is defined by [PMx6A](#).

SmiCmdBlkx00 SmiCmdPort

Bits	Description
7:0	SmiCmdPort . Read-write. Reset: 0. When SMI command port is enabled, a write to this port generates SMI, NMI or IRQ3 depending on the setting of SMIxB0[23:22] . A read from this port returns the previously written value but does not generate SMI.

SmiCmdBlkx01 SmiCmdStatus

Bits	Description
7:0	SmiCmdStatus . Read-write. Reset: 0. Used by BIOS and OS.

3.26.16 SMI Registers

SMI register space is accessed through the AcpiMmio region. The SMI registers range from FED8_0000h+200h to FED8_0000h+2FFh. See [PMx04\[MmioEn\]](#).

SMIx00 Event_Status

Bits	Description
31:0	EventStatus. Read; write-1-to-clear. Reset: X. This is a mirror register of the standard ACPI register AcpiGpe0Blkx00 [EventStatus] . Each event status bit is set when the selected event input equals to the corresponding value in SMIx08 [SciTrig] .

SMIx04 Event_Enable

Bits	Description
31:0	EventEnable. Read-write. Reset: 0. This is the mirror register of the standard ACPI register AcpiGpe0Blkx04 [EventEnable] . Each bit controls whether ACPI should generate wake up and SCI interrupt.

SMIx08 SciTrig

Each bit in this register controls the way to set each corresponding bit in [SMIx00 \[Event_Status\]](#).

Bits	Description
31	SciTrig31. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 31. 0=Active low. 1=Active high.
30	SciTrig30. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 30. 0=Active low. 1=Active high.
29	SciTrig29. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 29. 0=Active low. 1=Active high.
28	SciTrig28. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 28. 0=Active low. 1=Active high.
27	SciTrig27. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 27. 0=Active low. 1=Active high.
26	SciTrig26. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 26. 0=Active low. 1=Active high.
25	SciTrig25. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 25. 0=Active low. 1=Active high.
24	SciTrig24. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 24. 0=Active low. 1=Active high.
23	SciTrig23. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 23. 0=Active low. 1=Active high.
22	SciTrig22. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 22. 0=Active low. 1=Active high.
21	SciTrig21. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 21. 0=Active low. 1=Active high.

20	SciTrig20. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 20. 0=Active low. 1=Active high.
19	SciTrig19. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 19. 0=Active low. 1=Active high.
18	SciTrig18. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 18. 0=Active low. 1=Active high.
17	SciTrig17. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 17. 0=Active low. 1=Active high.
16	SciTrig16. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 16. 0=Active low. 1=Active high.
15	SciTrig15. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 15. 0=Active low. 1=Active high.
14	SciTrig14. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 14. 0=Active low. 1=Active high.
13	SciTrig13. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 13. 0=Active low. 1=Active high.
12	SciTrig12. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 12. 0=Active low. 1=Active high.
11	SciTrig11. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 11. 0=Falling edge. 1=Active high.
10	SciTrig10. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 10. 0=Active low. 1=Active high.
9	SciTrig9. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 9. 0=Active low. 1=Active high.
8	SciTrig8. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 8. 0=Active low. 1=Active high.
7	SciTrig7. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 7. 0=Active low. 1=Active high.
6	SciTrig6. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 6. 0=Active low. 1=Active high.
5	SciTrig5. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 5. 0=Active low. 1=Active high.
4	SciTrig4. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 4. 0=Active low. 1=Active high.
3	SciTrig3. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 3. 0=Active low. 1=Active high.
2	SciTrig2. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 2. 0=Active low. 1=Active high.
1	SciTrig1. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 1. 0=Active low. 1=Active high.
0	SciTrig0. Read-write. Reset: 1. The bit controls the way to set Event_Status bit 0. 0=Active low. 1=Active high.

SMIx0C SciLevl

Reset: 0000_0000h. This register specifies the trigger mode for each of the corresponding bit in [SMIx00 \[Event_Status\]](#).

Bits	Description
31	SciLevl31. Read-write. 0=Edge trigger. 1=Level trigger.
30	SciLevl30. Read-write. 0=Edge trigger. 1=Level trigger.
29	SciLevl29. Read-write. 0=Edge trigger. 1=Level trigger.
28	SciLevl28. Read-write. 0=Edge trigger. 1=Level trigger.
27	SciLevl27. Read-write. 0=Edge trigger. 1=Level trigger.
26	SciLevl26. Read-write. 0=Edge trigger. 1=Level trigger.
25	SciLevl25. Read-write. 0=Edge trigger. 1=Level trigger.
24	SciLevl24. Read-write. 0=Edge trigger. 1=Level trigger.
23	SciLevl23. Read-write. 0=Edge trigger. 1=Level trigger.
22	SciLevl22. Read-write. 0=Edge trigger. 1=Level trigger.
21	SciLevl21. Read-write. 0=Edge trigger. 1=Level trigger.
20	SciLevl20. Read-write. 0=Edge trigger. 1=Level trigger.
19	SciLevl19. Read-write. 0=Edge trigger. 1=Level trigger.
18	SciLevl18. Read-write. 0=Edge trigger. 1=Level trigger.
17	SciLevl17. Read-write. 0=Edge trigger. 1=Level trigger.
16	SciLevl16. Read-write. 0=Edge trigger. 1=Level trigger.
15	SciLevl15. Read-write. 0=Edge trigger. 1=Level trigger.
14	SciLevl14. Read-write. 0=Edge trigger. 1=Level trigger.
13	SciLevl13. Read-write. 0=Edge trigger. 1=Level trigger.
12	SciLevl12. Read-write. 0=Edge trigger. 1=Level trigger.
11	SciLevl11. Read-write. 0=Edge trigger. 1=Level trigger.
10	SciLevl10. Read-write. 0=Edge trigger. 1=Level trigger.
9	SciLevl9. Read-write. 0=Edge trigger. 1=Level trigger.
8	SciLevl8. Read-write. 0=Edge trigger. 1=Level trigger.
7	SciLevl7. Read-write. 0=Edge trigger. 1=Level trigger.
6	SciLevl6. Read-write. 0=Edge trigger. 1=Level trigger.
5	SciLevl5. Read-write. 0=Edge trigger. 1=Level trigger.
4	SciLevl4. Read-write. 0=Edge trigger. 1=Level trigger.
3	SciLevl3. Read-write. 0=Edge trigger. 1=Level trigger.
2	SciLevl2. Read-write. 0=Edge trigger. 1=Level trigger.
1	SciLevl1. Read-write. 0=Edge trigger. 1=Level trigger.
0	SciLevl0. Read-write. 0=Edge trigger. 1=Level trigger.

SMIx10 SmiSciStatus

Bits	Description
31:0	SmiSciStatus. Read; write-1-to-clear. Reset: 0. Each bit indicates the corresponding SmiSci status. The input of each bit is controlled by the corresponding SMIx08 [SciTrig] bit. Note: this function can be considered as a superset of SMIx00 [Event_Status] . When one of the bits is set and its SMIx14 [SmiSciEn] is also set, it triggers a SMI to call the BIOS. After the BIOS has serviced the SMM and cleared its status, the internal logic automatically sets the corresponding SMIx00 [Event_Status] bit and thereby triggering a SCI.

SMIx14 SmiSciEn

Bits	Description
31:0	SmiSciEn. Read-write. Reset: 0. Each bit controls if SMI message is generated when the corresponding SMIx10 [SmiSciStatus] bit is set to 1. For each bit, 0=Not to send SMI message when the corresponding SMIx10 [SmiSciStatus] bit is set. 1=Send SMI message when the corresponding SMIx10 [SmiSciStatus] bit is set.

SMIx18 SwSciEn

Bits	Description
31:0	SwSciEn. Read-write. Reset: 0. This register is used as a software mechanism to trigger SCI. For each bit, 1=Software can write to SMIx1C [SwSciData] and set the corresponding SMIx00 [Event_Status] bit. Note: the setting of this bit needs to match with SMIx08 [SciTrig] and SMIx0C [SciLevl] in order to set the status bit.

SMIx1C SwSciData

Bits	Description
31:0	SwSciData. Read-write. Reset: 0. This is the software data path to set the corresponding SMIx00 [Event_Status] bit when SMIx18 [SwSciEn] is set.

SMIx20 SciSleepDisable

Bits	Description
31:0	SciSleepDisable. Read-write. Reset: 0. This register is used to ignore EVENT pins that are powered in the main power domain instead of auxiliary power domain. For each bit, 1=The corresponding SMIx00 [Event_Status] bit is masked off whenever the system goes to S3 or higher sleep state.

SMI_x30 CapturedData

Bits	Description
31:0	CapturedData . Read-only. Reset: X. This is the buffer to capture write data for the last transaction that caused an SMI. Note: this buffer has no meaning for a read trap.

SMI_x34 CapturedValid

Bits	Description										
7:4	Reserved.										
3:0	CapturedValid . Read-only. Reset: X. This is the byte valid buffer to signal which byte is captured for the last transaction that caused the SMI. <table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>byte 0</td></tr> <tr> <td>[1]</td><td>byte 1</td></tr> <tr> <td>[2]</td><td>byte 2</td></tr> <tr> <td>[3]</td><td>byte 3</td></tr> </table>	Bit	Definition	[0]	byte 0	[1]	byte 1	[2]	byte 2	[3]	byte 3
Bit	Definition										
[0]	byte 0										
[1]	byte 1										
[2]	byte 2										
[3]	byte 3										

SMI_x38 EPBIF_AER_Straps

Bits	Description
31:28	Reserved.
27	StrapBifInternalErrEnFch . Read-write. Reset: 0. Internal error enable.
26	StrapBifPoisonedAdvisoryNonfatalAFch . Read-write. Reset: 1. Poisoned TLP as advisory nonfatal.
25	StrapBifAcsDirectTranslatedP2pFch . Read-write. Reset: 1. ACS direct translated P2P enable.
24	StrapBifAcsUpstreamForwardingFch . Read-write. Reset: 1. ACS upstream forwarding enable.
23	StrapBifAcsP2pCompletionRedirectFch . Read-write. Reset: 1. ACS P2P completion redirect enable.
22	StrapBifAcsP2pRequestRedirectFch . Read-write. Reset: 1. ACS P2P request redirect enable.
21	StrapBifAcsTranslationBlockingFch . Read-write. Reset: 1. ACS translation blocking enable.
20	StrapBifAcsSourceValidationFch . Read-write. Reset: 1. ACS source validation enable.
19	StrapBifAcsEnFch . Read-write. Reset: 1. ACS enable.
18	StrapBifFirstRcvdErrLogFch . Read-write. Reset: 1. First received error log.
17	StrapBifEcrcCheckEnFch . Read-write. Reset: 1. ECRC check enable.
16	StrapBifEcrcGenEnFch . Read-write. Reset: 0. ECRC generate enable.
15	StrapBifCplAbortErrEnFch . Read-write. Reset: 1. Completer abort error enable.
14	StrapBifRxIgnoreVend0UrFch . Read-write. Reset: 1. Ignore Vendor 0 error.
13	StrapBifRxIgnoreTcErrFch . Read-write. Reset: 1. Ignore traffic class error.
12	StrapBifRxIgnoreMsgErrFch . Read-write. Reset: 1. Ignore message error.
11	StrapBifRxIgnoreMaxPayloadErrFch . Read-write. Reset: 1. Ignore maximum payload error.

10	StrapBifRxIgnoreLenMismatchErrFch. Read-write. Reset: 1. Ignore length mismatch error.
9	StrapBifRxIgnoreIoUrErrFch. Read-write. Reset: 1. Ignore IO UR error.
8	StrapBifRxIgnoreIoErrFch. Read-write. Reset: 1. Ignore IO error.
7	StrapBifRxIgnoreEpErrFch. Read-write. Reset: 1. Ignore poisoned TLP error.
6	StrapBifRxIgnoreCplErrFch. Read-write. Reset: 1. Ignore completion error.
5	StrapBifRxIgnoreCfgUrFch. Read-write. Reset: 1. Ignore configuration UR error.
4	StrapBifRxIgnoreCfgErrFch. Read-write. Reset: 1. Ignore configuration error.
3	StrapBifRxIgnoreBeErrFch. Read-write. Reset: 1. Ignore byte enable error.
2	StrapBifErrReportingDisFch. Read-write. Reset: 1. Error reporting disable.
1	StrapBifAerEnFch. Read-write. Reset: 1. AER enable.
0	StrapBifStickyOverrideS5. Read-write. Reset: 0. 1=Values in this register would override straps loaded from EEPROM.

SMI_x3C DataErrorStatus

Bits	Description
31:8	Reserved.
7	SIrqIochk. Read; write-1-to-clear. Reset: 0. Serial Iochk error.
6	SataPerr. Read; write-1-to-clear. Reset: 0. BIOS: See 2.17.3.9. SATA controller internal parity error status.
5	UmiUncorrectableErr. Read; write-1-to-clear. Reset: 0. UMI uncorrectable error status.
4	UmiCorrectableErr. Read; write-1-to-clear. Reset: 0. UMICorrectable error status.
3	AbUmiGppPerr. Read; write-1-to-clear. Reset: 0. AB/UMI/GPP parity error status.
2	ApuGppSerr. Read; write-1-to-clear. Reset: 0. APU/GPP devices SERR error status.
1	InternalPerr. Read; write-1-to-clear. Reset: 0. Internal devices PERR error status.
0	InternalSerr. Read; write-1-to-clear. Reset: 0. Internal devices SERR error status.

SMI_x40 SciMap0

Bits	Description
31:29	Reserved.
28:24	SciMap3. Read-write. Reset: 0. Specifies the mapping of GEVENT3 to one of the 32 bits in SMI_x00 [Event_Status] . See: SciMap0.
23:21	Reserved.
20:16	SciMap2. Read-write. Reset: 0. Specifies the mapping of GEVENT2 to one of the 32 bits in SMI_x00 [Event_Status] . See: SciMap0.
15:13	Reserved.
12:8	SciMap1. Read-write. Reset: 0. Specifies the mapping of GEVENT1 to one of the 32 bits in SMI_x00 [Event_Status] . See: SciMap0.

7:5	Reserved.										
4:0	SciMap0. Read-write. Reset: 0. Specifies the mapping of GEVENT0 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx44 SciMap1

Bits	Description										
31:29	Reserved.										
28:24	SciMap7. Read-write. Reset: 0. Specifies the mapping of GEVENT7 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap4.										
23:21	Reserved.										
20:16	SciMap6. Read-write. Reset: 0. Specifies the mapping of GEVENT6 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap4.										
15:13	Reserved.										
12:8	SciMap5. Read-write. Reset: 0. Specifies the mapping of GEVENT5 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap4.										
7:5	Reserved.										
4:0	SciMap4. Read-write. Reset: 0. Specifies the mapping of GEVENT4 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx48 SciMap2

Bits	Description
31:29	Reserved.
28:24	SciMap11. Read-write. Reset: 0. Specifies the mapping of GEVENT11 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap8.
23:21	Reserved.
20:16	SciMap10. Read-write. Reset: 0. Specifies the mapping of GEVENT10 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap8.
15:13	Reserved.
12:8	SciMap9. Read-write. Reset: 0. Specifies the mapping of GEVENT9 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap8.

7:5	Reserved.										
4:0	SciMap8. Read-write. Reset: 0. Specifies the mapping of GEVENT8 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx4C SciMap3

Bits	Description										
31:29	Reserved.										
28:24	SciMap15. Read-write. Reset: 0. Specifies the mapping of GEVENT15 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap12.										
23:21	Reserved.										
20:16	SciMap14. Read-write. Reset: 0. Specifies the mapping of GEVENT14 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap12.										
15:13	Reserved.										
12:8	SciMap13. Read-write. Reset: 0. Specifies the mapping of GEVENT13 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap12.										
7:5	Reserved.										
4:0	SciMap12. Read-write. Reset: 0. Specifies the mapping of GEVENT12 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx50 SciMap4

Bits	Description
31:29	Reserved.
28:24	SciMap19. Read-write. Reset: 0. Specifies the mapping of GEVENT19 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap16.
23:21	Reserved.
20:16	SciMap18. Read-write. Reset: 0. Specifies the mapping of GEVENT18 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap16.
15:13	Reserved.
12:8	SciMap17. Read-write. Reset: 0. Specifies the mapping of GEVENT17 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap16.

7:5	Reserved.										
4:0	SciMap16. Read-write. Reset: 0. Specifies the mapping of GEVENT16 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx54 SciMap5

Bits	Description										
31:29	Reserved.										
28:24	SciMap23. Read-write. Reset: 0. Specifies the mapping of GEVENT23 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap20.										
23:21	Reserved.										
20:16	SciMap22. Read-write. Reset: 0. Specifies the mapping of GEVENT22 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap20.										
15:13	Reserved.										
12:8	SciMap21. Read-write. Reset: 0. Specifies the mapping of GEVENT21 to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap20.										
7:5	Reserved.										
4:0	SciMap20. Read-write. Reset: 0. Specifies the mapping of GEVENT20 to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx58 SciMap6

Bits	Description
31:21	Reserved.
20:16	SciMap26. Read-write. Reset: 0. Specifies the mapping of USB_PME (device 16h) to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap24.
15:13	Reserved.
12:8	SciMap25. Read-write. Reset: 0. Specifies the mapping of USB_PME (device 13h) to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap24.

7:5	Reserved.										
4:0	SciMap24. Read-write. Reset: 0. Specifies the mapping of USB_PME (device 12h) to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
<u>Bits</u>	<u>Definition</u>										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx5C SciMap7

Bits	Description
31:0	Reserved.

SMIx60 SciMap8

Bits	Description
31:0	Reserved.

SMIx64 SciMap9

Bits	Description										
31:21	Reserved.										
20:16	SciMap38. Read-write. Reset: 0. Specifies the mapping of SATA1_PME to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap36.										
15:13	Reserved.										
12:8	SciMap37. Read-write. Reset: 0. Specifies the mapping of SATA0_PME to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap36.										
7:5	Reserved.										
4:0	SciMap36. Read-write. Reset: 0. Specifies the mapping of HD_Audio_PME to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
<u>Bits</u>	<u>Definition</u>										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx68 SciMap10

Bits	Description
31:29	Reserved.
28:24	SciMap43. Read-write. Reset: 0. Specifies the mapping of WAKE# pin to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap40.

23:21	Reserved.										
20:16	SciMap42. Read-write. Reset: 0. Specifies the mapping of CIR_PME to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap40.										
15:13	Reserved.										
12:8	SciMap41. Read-write. Reset: 0. Specifies the mapping of EC1_PME to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap40.										
7:5	Reserved.										
4:0	SciMap40. Read-write. Reset: 0. Specifies the mapping of EC0_PME to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
<u>Bits</u>	<u>Definition</u>										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx6C SciMap11

Bits	Description										
31:29	Reserved.										
28:24	SciMap47. Read-write. Reset: 0. Specifies the mapping of SMBUS0 Interrupt event to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap44.										
23:21	Reserved.										
20:16	SciMap46. Read-write. Reset: 0. Specifies the mapping of ASF slave interrupt event to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap44.										
15:13	Reserved.										
12:8	SciMap45. Read-write. Reset: 0. Specifies the mapping of ASF master interrupt event to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap44.										
7:5	Reserved.										
4:0	SciMap44. Read-write. Reset: 0. Specifies the mapping of internal FAN/THERMAL event to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
<u>Bits</u>	<u>Definition</u>										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx70 SciMap12

Bits	Description
31:29	Reserved.
28:24	SciMap51. Read-write. Reset: 0. Specifies the mapping of PWRBTN status to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap48.
23:21	Reserved.

20:16	SciMap50. Read-write. Reset: 0. Specifies the mapping of LLB# to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap48.										
15:13	Reserved.										
12:8	SciMap49. Read-write. Reset: 0. Specifies the mapping of internal traffic monitor to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap48.										
7:5	Reserved.										
4:0	SciMap48. Read-write. Reset: 0. Specifies the mapping of TWARD pin to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx74 SciMap13

Bits	Description										
31:29	Reserved.										
28:24	SciMap55. Read-write. Reset: 0. Specifies the mapping of RAS_event status to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap52.										
23:21	Reserved.										
20:16	SciMap54. Read-write. Reset: 0. Specifies the mapping of SCI assertion message from APU to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap52.										
15:13	Reserved.										
12:8	SciMap53. Read-write. Reset: 0. Specifies the mapping of HW assertion message from APU to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap52.										
7:5	Reserved.										
4:0	SciMap52. Read-write. Reset: 0. Specifies the mapping of PROHOT# pin to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx78 SciMap14

Bits	Description
31:29	Reserved.
28:24	Reserved.
23:21	Reserved.
20:16	SciMap58. Read-write. Reset: 0. Specifies the mapping of AcDcTimerEvent to one of the 32 bits in SMIx00 [Event_Status] . See: SciMap56.

15:13	Reserved.										
12:8	SciMap57 . Read-write. Reset: 0. Specifies the mapping of XHC1 (USB3 controller 1) pin to one of the 32 bits .										
7:5	Reserved.										
4:0	SciMap56 . Read-write. Reset: 0. Specifies the mapping of XHC0 (USB3 controller 0) pin to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										

SMIx7C SciMap15

Bits	Description										
31:29	Reserved.										
28:24	SciMap63 . Read-write. Reset: 0. Specifies the mapping of TempStatus5 (auto-polling temperature) to one of the 32 bits in SMIx00 [Event_Status] . <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00000b</td><td>map to the input of SMIx00 [Event_Status] bit [0]</td></tr> <tr> <td>00001b</td><td>map to the input of SMIx00 [Event_Status] bit [1]</td></tr> <tr> <td>...</td><td>...</td></tr> <tr> <td>11111b</td><td>map to the input of SMIx00 [Event_Status] bit [31]</td></tr> </table>	Bits	Definition	00000b	map to the input of SMIx00 [Event_Status] bit [0]	00001b	map to the input of SMIx00 [Event_Status] bit [1]	11111b	map to the input of SMIx00 [Event_Status] bit [31]
Bits	Definition										
00000b	map to the input of SMIx00 [Event_Status] bit [0]										
00001b	map to the input of SMIx00 [Event_Status] bit [1]										
...	...										
11111b	map to the input of SMIx00 [Event_Status] bit [31]										
23:0	Reserved.										

SMIx80 SMIStatus0

Bits	Description
31	GppPME3Event31 . Read; write-1-to-clear. Reset: 0. Status of GPP PME from function 3, device 15h.
30	GppPME2Event30 . Read; write-1-to-clear. Reset: 0. Status of GPP PME from function 2, device 15h.
29	GppPME1Event29 . Read; write-1-to-clear. Reset: 0. Status of GPP PME from function 1, device 15h.
28	AnySBGppPMEEvent28 . Read; write-1-to-clear. Reset: 0. Status of All GPP PME.
27	UsbWakup2Event27 . Read; write-1-to-clear. Reset: 0. Status of USB device 16h PME.
26	UsbWakup2Event26 . Read; write-1-to-clear. Reset: 0. Status of USB device 14h PME.
25	UsbWakup1Event25 . Read; write-1-to-clear. Reset: 0. Status of USB device 13h PME.
24	UsbWakup0Event24 . Read; write-1-to-clear. Reset: 0. Status of USB device 12h PME.
23	Gevent23StatusEvent23 . Read; write-1-to-clear. Reset: 0. Status of Gevent23.
22	Gevent22StatusEvent22 . Read; write-1-to-clear. Reset: 0. Status of Gevent22.
21	Gevent21StatusEvent21 . Read; write-1-to-clear. Reset: 0. Status of Gevent21.
20	Gevent20StatusEvent20 . Read; write-1-to-clear. Reset: 0. Status of Gevent20.

19	Gevent19StatusEvent19. Read; write-1-to-clear. Reset: 0. Status of Gevent19.
18	Gevent18StatusEvent18. Read; write-1-to-clear. Reset: 0. Status of Gevent18.
17	Gevent17StatusEvent17. Read; write-1-to-clear. Reset: 0. Status of Gevent17.
16	Gevent16StatusEvent16. Read; write-1-to-clear. Reset: 0. Status of Gevent16.
15	Gevent15StatusEvent15. Read; write-1-to-clear. Reset: 0. Status of Gevent15.
14	Gevent14StatusEvent14. Read; write-1-to-clear. Reset: 0. Status of Gevent14.
13	Gevent13StatusEvent13. Read; write-1-to-clear. Reset: 0. Status of Gevent13.
12	Gevent12StatusEvent12. Read; write-1-to-clear. Reset: 0. Status of Gevent12.
11	Gevent11StatusEvent11. Read; write-1-to-clear. Reset: 0. Status of Gevent11.
10	Gevent10StatusEvent10. Read; write-1-to-clear. Reset: 0. Status of Gevent10.
9	Gevent9StatusEvent9. Read; write-1-to-clear. Reset: 0. Status of Gevent9.
8	Gevent8StatusEvent8. Read; write-1-to-clear. Reset: 0. Status of Gevent8.
7	Gevent7StatusEvent7. Read; write-1-to-clear. Reset: 0. Status of Gevent7.
6	Gevent6StatusEvent6. Read; write-1-to-clear. Reset: 0. Status of Gevent6.
5	Gevent5StatusEvent5. Read; write-1-to-clear. Reset: 0. Status of Gevent5.
4	Gevent4StatusEvent4. Read; write-1-to-clear. Reset: 0. Status of Gevent4.
3	Gevent3StatusEvent3. Read; write-1-to-clear. Reset: 0. Status of Gevent3.
2	Gevent2StatusEvent2. Read; write-1-to-clear. Reset: 0. Status of Gevent2.
1	Gevent1StatusEvent1. Read; write-1-to-clear. Reset: 0. Status of Gevent1.
0	Gevent0StatusEvent0. Read; write-1-to-clear. Reset: 0. Status of Gevent0.

SMI_x84 SMIStatus1

Bits	Description
31	TempTsiStsEvent63. Read; write-1-to-clear. Reset: 0. Status of TempTsi event.
30:27	Reserved.
26	AcDcTimerEventEvent58. Read; write-1-to-clear. Reset: 0. Status of AcDcTimer wake up event.
25	Reserved.
24	Xhc0PmeEvent56. Read; write-1-to-clear. Reset: 0. Status of XHC0 (device 10h, function 0) PME.
23	RasEvent55. Read; write-1-to-clear. Reset: 0. BIOS: See 2.17.3.9. Internal devices SERR error status.
22	ApuSciAssertionEvent54. Read; write-1-to-clear. Reset: 0. Status of NB SCI request.
21	ApuHwAssertionEvent53. Read; write-1-to-clear. Reset: 0. Status of APU HW assertion.
20	ProcHotEvent52. Read; write-1-to-clear. Reset: 0. Status of ProcHot event.
19	PwrButtonEvent51. Read; write-1-to-clear. Reset: 0. Status of PwrButton (rising edge).
18	IllbEvent50. Read; write-1-to-clear. Reset: 0. Status of iLLB# assertion.
17	TrafficMonitorIntrEvent49. Read; write-1-to-clear. Reset: 0. Status of FCH Traffic Monitor Interrupt.
16	TwarnEvent48. Read; write-1-to-clear. Reset: 0. Status of FCH TWARN.

15	Smbus0Event47. Read; write-1-to-clear. Reset: 0. Status of FCH SMBUS0 master interrupt.
14	AsfSlaveIntrEvent46. Read; write-1-to-clear. Reset: 0. Status of FCH ASF slave interrupt.
13	AsfMasterIntrEvent45. Read; write-1-to-clear. Reset: 0. Status of FCH ASF master interrupt.
12	FanThermalGeventEvent44. Read; write-1-to-clear. Reset: 0. Status of FCH fan thermal.
11	AltMmTimerStsEvent43. Read; write-1-to-clear. Reset: 0. Status of AltHpetTimer Alarm.
10	CirPmeEvent42. Read; write-1-to-clear. Reset: 0. Status of FCH CIR PME.
9	GpioEvent41. Read; write-1-to-clear. Reset: 0. Status of FCH GPIO Control interrupt
8	EcGevent0Event40. Read; write-1-to-clear. Reset: 0. Status of FCH ECG Gevent0(iEcSCi).
7	Reserved.
6	SataGevent1Event38. Read; write-1-to-clear. Reset: 0. Status of FCH SATA Gevent1.
5	SataGevent0Event37. Read; write-1-to-clear. Reset: 0. Status of FCH SATA Gevent0.
4	AzaliaPmeEvent36. Read; write-1-to-clear. Reset: 0. Status of FCH HD Audio PME.
3	Reserved.
2	Reserved.
1	FakeSts0Event33. Read; write-1-to-clear. Reset: 0. Status of FCH FakeSts0.
0	GppHPEvent32. Read; write-1-to-clear. Reset: 0. Status of GPP Hot Plug (HP) from device 15h.

SMI_x88 SMIStatus2

Bits	Description
31	Reserved.
30	Reserved.
29	Reserved.
28	SataFlrEvent92. Read; write-1-to-clear. Reset: 0. Status of SATA FLR event.
27	Reserved.
26	Emulate64Event90. Read; write-1-to-clear. Reset: 0. Status of Emulation IO Port 60h/64h.
25	ThermaltripEvent89. Read; write-1-to-clear. Reset: 0. Status of ThermalTrip event.
24:22	Reserved.
21	GppSerr0Event84. Read; write-1-to-clear. Reset: 0. SERR error from FCH GPP device 15h, function 0~3.
20	PciSerrEvent84. Read; write-1-to-clear. Reset: 0. Status of Serr assertion on PCI bus.
19	ProtHotEvent83. Read; write-1-to-clear. Reset: 0. Status of ProtHot event.
18	VbatLowEvent82. Read; write-1-to-clear. Reset: 0. Status of VBAT low.
17	Reserved.
16	XhcErrEvent80. Read; write-1-to-clear. Reset: 0. Status of XHC error.
15	EcSmi0Event79. Read; write-1-to-clear. Reset: 0. Status of IMC SMI request.
14	Smbus0IntrEvent78. Read; write-1-to-clear. Reset: 0. Status of SMBUS0 interrupt request.
13	SerialIrqSmiEvent77. Read; write-1-to-clear. Reset: 0. Status of SMI request from Serial IRQ.
12	UsbSmiEvent76. Read; write-1-to-clear. Reset: 0. Status of USB SMI request.

11	SmiCmdportEvent75. Read; write-1-to-clear. Reset: 0. Status of Writing SMI Command Port.
10	PwrbtnEvent74. Read; write-1-to-clear. Reset: 0. Status of Power Button being pressed.
9	BiosRlsEvent73. Read; write-1-to-clear. Reset: 0. Status of BIOS_RLS. See PMx74[BiosRls] .
8	GblRlsEvent72. Read; write-1-to-clear. Reset: 0. Status of GBL event. See AcpiPm1CntBlkx00[GblRls] .
7	Reserved.
6	Reserved.
5	Reserved.
4	Reserved.
3	SataAhciSmiEvent67. Read; write-1-to-clear. Reset: 0. Status of SATA AHCI SMI request.
2	AL2H_ACPI_Assertion_Event67. Read; write-1-to-clear. Reset: 0. Status of AL2H ACPI Assertion.
1	SlpTypeEvent65. Read; write-1-to-clear. Reset: 0. Status of writing AcpiPm1CntBlkx00[SlpTyp] .
0	KbRstEvent64. Read; write-1-to-clear. Reset: 0. Status of KeyBoard Reset event.

SMI_x8C SmiStatus3

Bits	Description
31:0	Reserved.

SMI_x90 SmiStatus4

Bits	Description
31:29	Reserved.
28	CfgTrapping0Event156. Read; write-1-to-clear. Reset: 0. Status of PCI configuration cycle Trapping0 SMI request.
27:25	Reserved.
24	MemTrapping0Event152. Read; write-1-to-clear. Reset: 0. Status of memory Trapping0 SMI request.
23:21	Reserved.
20	IoTrapping0Event148. Read; write-1-to-clear. Reset: 0. Status of IO Trapping0 SMI request.
19:18	Reserved.
17	SoftResetEvent145. Read; write-1-to-clear. Reset: 0. Status of soft reset request. The soft request can be: <ul style="list-style-type: none"> • CF9h PCI reset. • ASF remote reset. • sync flood reset. • KBRST. • watchdog timer reset.
16	AbSmiTrapEvent144. Read; write-1-to-clear. Reset: 0. Status of AB SMI trapping request.
15	LongTimerEvent143. Read; write-1-to-clear. Reset: 0. Status of Long Timer SMI request.

14	ShortTimerEvent142. Read; write-1-to-clear. Reset: 0. Status of Short Timer SMI request.
13:6	Reserved.
5	FanIn0stsEvent133. Read; write-1-to-clear. Reset: 0. Status of FanIn0 event.
4:0	Reserved.

SMIx94 SMIPointer

This register is meant as a faster mechanism to locate the SMI source. BIOS can examine this register to find out the SMI source instead of reading [SMIx80 \[SmiStatus0\]](#) through [SMIx90 \[SmiStatus4\]](#) individually.

Bits	Description
15:6	Reserved.
5	SmiStatusSource4. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx90 [SmiStatus4] if the corresponding SMI enable is selected.
4	SmiStatusSource3. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx8C [SmiStatus3] if the corresponding SMI enable is selected.
3	SmiStatusSource2. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx88 [SmiStatus2] if the corresponding SMI enable is selected.
2	SmiStatusSource1. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx84 [SmiStatus1] if the corresponding SMI enable is selected.
1	SmiStatusSource0. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx80 [SmiStatus0] if the corresponding SMI enable is selected.
0	SmiSciSource. Read-only. Reset: 0. Indicates whether the SMI source is from SMIx10 [SmiSciStatus] .

SMIx96 SMI timer

There are two SMI timers: the short timer runs at 1 us unit time and the long timer runs at 1 ms unit time. This register is actually made up of two sets of registers depending on the setting of [SMIx98\[SmiTimerSel\]](#). If [SMIx98\[SmiTimerSel\]](#)==0, then [SMIx96](#) is for the short timer. If [SMIx98\[SmiTimerSel\]](#)==1, then [SMIx96](#) is for the long timer. The default setting selects this register as “SmiShortTimer”; software needs to set the “SmiTimerSel=1” to select this register as “SmiLongTimer”.

Bits	Description
15	TimerEn. Read-write. Reset: 0. 1=Enable the SMI short Timer or long timer, which is selected by SMIx98[SmiTimerSel] . 0=Disable.
14:0	SmiTimerCount. Read-write. Reset: 0. Actual timer duration = TimerTime + 1 unit.

SMIx98 SMITrig0

Bit [23:0] defines the trigger mode for 24 GEVENTS in [SMIx80\[23:0\]](#). Note these are different from [SMIx08 \[SciTrig\]](#).

Bits	Description
31	SmiEnB. Read-write. Reset: 1. 0=Enable SMI function. 1=Disable.
30	Reserved.

29	SmiTimerSel. Read-write. Reset: 0. 0=Select SMIx96 [SmiTimer] to be SmiShortTimer register. 1=Select SMIx96 [SmiTimer] to be SmiLongTimer register.
28	Reserved.
27	FakeSts2. Read-write. Reset: 1. Program the value to emulate an SMI input event.
26	FakeSts1. Read-write. Reset: 1. Program the value to emulate an SMI input event.
25	FakeSts0. Read-write. Reset: 1. Program the value to emulate an SMI input event.
24	Reserved.
23	SmiTrig23. Read-write. Reset: 1. 0=Active low. 1=Active high.
22	SmiTrig22. Read-write. Reset: 1. 0=Active low. 1=Active high.
21	SmiTrig21. Read-write. Reset: 1. 0=Active low. 1=Active high.
20	SmiTrig20. Read-write. Reset: 1. 0=Active low. 1=Active high.
19	SmiTrig19. Read-write. Reset: 1. 0=Active low. 1=Active high.
18	SmiTrig18. Read-write. Reset: 1. 0=Active low. 1=Active high.
17	SmiTrig17. Read-write. Reset: 1. 0=Active low. 1=Active high.
16	SmiTrig16. Read-write. Reset: 1. 0=Active low. 1=Active high.
15	SmiTrig15. Read-write. Reset: 1. 0=Active low. 1=Active high.
14	SmiTrig14. Read-write. Reset: 1. 0=Active low. 1=Active high.
13	SmiTrig13. Read-write. Reset: 1. 0=Active low. 1=Active high.
12	SmiTrig12. Read-write. Reset: 1. 0=Active low. 1=Active high.
11	SmiTrig11. Read-write. Reset: 1. 0=Active low. 1=Active high.
10	SmiTrig10. Read-write. Reset: 1. 0=Active low. 1=Active high.
9	SmiTrig9. Read-write. Reset: 1. 0=Active low. 1=Active high.
8	SmiTrig8. Read-write. Reset: 1. 0=Active low. 1=Active high.
7	SmiTrig7. Read-write. Reset: 1. 0=Active low. 1=Active high.
6	SmiTrig6. Read-write. Reset: 1. 0=Active low. 1=Active high.
5	SmiTrig5. Read-write. Reset: 1. 0=Active low. 1=Active high.
4	SmiTrig4. Read-write. Reset: 1. 0=Active low. 1=Active high.
3	SmiTrig3. Read-write. Reset: 1. 0=Active low. 1=Active high.
2	SmiTrig2. Read-write. Reset: 1. 0=Active low. 1=Active high.
1	SmiTrig1. Read-write. Reset: 1. 0=Active low. 1=Active high.
0	SmiTrig0. Read-write. Reset: 1. 0=Active low. 1=Active high.

SMIx9C SmiTrig1

Bit [23:0] defines the trigger mode for 24 IRQs.

Bits	Description
31:0	Reserved.

SMIA0 SmiControl0

This register specifies the control mechanism for SMI sources in [SMIA0\[15:0\]](#).

Bits	Description										
31:30	Smicontrol15 . Read-write. Reset: 0. Control for GEVENT15. See: Smicontrol0.										
29:28	Smicontrol14 . Read-write. Reset: 0. Control for GEVENT14. See: Smicontrol0.										
27:26	Smicontrol13 . Read-write. Reset: 0. Control for GEVENT13. See: Smicontrol0.										
25:24	Smicontrol12 . Read-write. Reset: 0. Control for GEVENT12. See: Smicontrol0.										
23:22	Smicontrol11 . Read-write. Reset: 0. Control for GEVENT11. See: Smicontrol0.										
21:20	Smicontrol10 . Read-write. Reset: 0. Control for GEVENT10. See: Smicontrol0.										
19:18	Smicontrol9 . Read-write. Reset: 0. Control for GEVENT9. See: Smicontrol0.										
17:16	Smicontrol8 . Read-write. Reset: 0. Control for GEVENT8. See: Smicontrol0.										
15:14	Smicontrol7 . Read-write. Reset: 0. Control for GEVENT7. See: Smicontrol0.										
13:12	Smicontrol6 . Read-write. Reset: 0. Control for GEVENT6. See: Smicontrol0.										
11:10	Smicontrol5 . Read-write. Reset: 0. Control for GEVENT5. See: Smicontrol0.										
9:8	Smicontrol4 . Read-write. Reset: 0. Control for GEVENT4. See: Smicontrol0.										
7:6	Smicontrol3 . Read-write. Reset: 0. Control for GEVENT3. See: Smicontrol0.										
5:4	Smicontrol2 . Read-write. Reset: 0. Control for GEVENT2. See: Smicontrol0.										
3:2	Smicontrol1 . Read-write. Reset: 0. Control for GEVENT1. See: Smicontrol0.										
1:0	Smicontrol0 . Read-write. Reset: 0. Control for GEVENT0. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										

SMIA4 SmiControl1

This register specifies the control mechanism for SMI sources in [SMIA4\[31:16\]](#).

Bits	Description
31:30	Smicontrol31 . Read-write. Reset: 0. Control for GPP PME(function 3, Device 15h).
29:28	Smicontrol30 . Read-write. Reset: 0. Control for GPP PME(function 2, Device 15h).
27:26	Smicontrol29 . Read-write. Reset: 0. Control for GPP PME(function 1, Device 15h).
25:24	Smicontrol28 . Read-write. Reset: 0. Control for any GPP PME(Device 15h).
23:22	Smicontrol27 . Read-write. Reset: 0. Control for USB_PME (Device 16h).
21:20	Smicontrol26 . Read-write. Reset: 0. Control for USB_PME (Device 14h). See: Smicontrol16.
19:18	Smicontrol25 . Read-write. Reset: 0. Control for USB_PME (Device 13h). See: Smicontrol16.
17:16	Smicontrol24 . Read-write. Reset: 0. Control for USB_PME (Device 12h). See: Smicontrol16.
15:14	Smicontrol23 . Read-write. Reset: 0. Control for GEVENT23. See: Smicontrol16.
13:12	Smicontrol22 . Read-write. Reset: 0. Control for GEVENT22. See: Smicontrol16.

11:10	Smicontrol21 . Read-write. Reset: 0. Control for GEVENT21. See: Smicontrol16.										
9:8	Smicontrol20 . Read-write. Reset: 0. Control for GEVENT20. See: Smicontrol16.										
7:6	Smicontrol19 . Read-write. Reset: 0. Control for GEVENT19. See: Smicontrol16.										
5:4	Smicontrol18 . Read-write. Reset: 0. Control for GEVENT18. See: Smicontrol16.										
3:2	Smicontrol17 . Read-write. Reset: 0. Control for GEVENT17. See: Smicontrol16.										
1:0	Smicontrol16 . Read-write. Reset: 0. Control for GEVENT16. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										

SMIx8 SmiControl2

This register specifies the control mechanism for SMI sources in [SMIx84](#)[15:0].

Bits	Description										
31:30	Smicontrol47 . Read-write. Reset: 0. Control for SMBUS0 interrupt. See: Smicontrol36.										
29:28	Smicontrol46 . Read-write. Reset: 0. Control for ASF Slave interrupt. See: Smicontrol36.										
27:26	Smicontrol45 . Read-write. Reset: 0. Control for ASF Master interrupt. See: Smicontrol36.										
25:24	Smicontrol44 . Read-write. Reset: 0. Control for fan thermal GEvent. See: Smicontrol36.										
23:22	SimControl43 . Read-write. Reset: 0. Control for ALTHPET_TimerSts .See: Smicontrol36.										
21:20	Smicontrol42 . Read-write. Reset: 0. Control for CIR PME. See: Smicontrol36.										
19:18	SimControl41 . Read-write. Reset: 0. Control for GPIO interrupt.See: Smicontrol36.										
17:16	Smicontrol40 . Read-write. Reset: 0. Control for IMC Gevent0. See: Smicontrol36.										
15:14	Reserved.										
13:12	Smicontrol38 . Read-write. Reset: 0. Control for SATA Gevent1. See: Smicontrol36.										
11:10	Smicontrol37 . Read-write. Reset: 0. Control for SATA Gevent0. See: Smicontrol36.										
9:8	Smicontrol36 . Read-write. Reset: 0. Control for PME from HD Audio. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										
7:6	Reserved.										
5:4	Reserved.										
3:2	Smicontrol33 . Read-write. Reset: 0. Control for FakeSts0.										
1:0	Smicontrol32 . Read-write. Reset: 0. Control for GPP HP (function 0-3, Device 15h).										

SMIxAC SmiControl3

This register specifies the control mechanism for SMI sources in [SMIx84](#)[31:16].

Bits	Description										
31:30	Smicontrol63. Read-write. Reset: 0. Control for TempTsi event. See: Smicontrol48.										
29:22	Reserved.										
21:20	Smicontrol58. Read-write. Reset: 0. Control for AcDcTimer wake up event (Wake Device in ACPI4.0). See: Smicontrol48.										
19:18	Reserved.										
17:16	Smicontrol56. Read-write. Reset: 0. Control for XHC0 (device 10h, function 0) PME. See: Smicontrol48.										
15:14	Smicontrol55. Read-write. Reset: 0. Control for internal devices SERR error status. See: Smicontrol48.										
13:12	Smicontrol54. Read-write. Reset: 0. Control for APU SCI request. See: Smicontrol48.										
11:10	Smicontrol53. Read-write. Reset: 0. Control for APU HW assertion. See: Smicontrol48.										
9:8	Smicontrol52. Read-write. Reset: 0. Control for ProcHot event. See: Smicontrol48.										
7:6	Smicontrol51. Read-write. Reset: 0. Control for Power button event. See: Smicontrol48.										
5:4	Smicontrol50. Read-write. Reset: 0. Control for iLLB#. See: Smicontrol48.										
3:2	Smicontrol49. Read-write. Reset: 0. Control for internal Traffic monitor interrupt. See: Smicontrol48.										
1:0	Smicontrol48. Read-write. Reset: 0. Control for TWARN#. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										

SMIxB0 SmiControl4

This register specifies the control mechanism for SMI sources in [SMIx88](#)[15:0].

Bits	Description
31:30	Smicontrol79. Read-write. Reset: 0. Control for IMC SMI request0. See: Smicontrol65.
29:28	Smicontrol78. Read-write. Reset: 0. Control for SMBUS0 interrupt. See: Smicontrol65.
27:26	Smicontrol77. Read-write. Reset: 0. Control for SMI request form serial IRQ. See: Smicontrol65.
25:24	Smicontrol76. Read-write. Reset: 0. Control for USB SMI request. See: Smicontrol65.
23:22	Smicontrol75. Read-write. Reset: 0. Control for writing SMI command port at SmiCmdBlkx00 . See: Smicontrol65.
21:20	Smicontrol74. Read-write. Reset: 0. Control for power button being pressed. See: Smicontrol65.
19:18	Smicontrol73. Read-write. Reset: 0. Control for writing PMx74 [BiosRIs]. See: Smicontrol65.
17:16	Smicontrol72. Read-write. Reset: 0. Control for writing AcpiPm1CntBlkx00 [GblRIs]. See: Smicontrol65.
15:14	Reserved.
13:12	Reserved.
11:10	Reserved.

9:8	Reserved.										
7:6	Smicontrol67 . Read-write. Reset: 0. Control for SATA AHCI event. See: Smicontrol65.										
5:4	Smicontrol66 . Read-write. Reset: 0. Control for iAL2H ACPI Assertion. See: Smicontrol65.										
3:2	Smicontrol65 . Read-write. Reset: 0. Control for writing AcpiPm1CntBlkx00[SlpTyp] to put the system in S state. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										
1:0	Reserved.										

SMIxB4 SmiControl5

This register specifies the control mechanism for SMI sources in [SMIx88](#)[31:16].

Bits	Description										
31:30	Reserved.										
29:28	Reserved.										
27:26	Reserved.										
25:24	Smicontrol92 . Read-write. Reset: 0. Control for SATA FLR. See: Smicontrol80.										
23:22	Reserved.										
21:20	Smicontrol90 . Read-write. Reset: 0. Control for Emulation64. See: Smicontrol80.										
19:18	Smicontrol89 . Read-write. Reset: 0. Control for ThermalTrip# assertion. See: Smicontrol80.										
17:12	Reserved.										
11:10	Smicontrol85 . Read-write. Reset: 0. Control for SB any GPP Serr#. See: Smicontrol80.										
9:8	Smicontrol84 . Read-write. Reset: 0. Control for SERR#. See: Smicontrol80.										
7:6	Smicontrol83 . Read-write. Reset: 0. Control for ProcHot. See: Smicontrol80.										
5:4	Smicontrol82 . Read-write. Reset: 0. Control for VBAT low. See: Smicontrol80.										
3:2	Smicontrol81 . Read-write. Reset: 0. Control for Intruder event. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										
1:0	Smicontrol80 . Read-write. Reset: 0. Control for IMC SMI request1. <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
<u>Bits</u>	<u>Definition</u>										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										

SMIxB8 SmiControl6

This register specifies the control mechanism for SMI sources in [SMIx8C](#)[15:0].

Bits	Description
31:0	Reserved.

SMIXBC SmiControl7

This register specifies the control mechanism for SMI sources in [SMIX8C](#)[31:16].

Bits	Description
31:0	Reserved.

SMIXC0 SmiControl8

This register specifies the control mechanism for SMI sources in [SMIX90](#)[15:0].

Bits	Description										
31:30	Smicontrol143. Read-write. Reset: 0. Control for Long timer. See: Smicontrol133.										
29:28	Smicontrol142. Read-write. Reset: 0. Control for Short timer. See: Smicontrol133.										
27:12	Reserved.										
11:10	Smicontrol133. Read-write. Reset: 0. Control for Fan0 Tach too slow event. <table data-bbox="267 924 649 1102"> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ 13</td></tr> </table>	Bits	Definition	00b	Disable	01b	SMI	10b	NMI	11b	IRQ 13
Bits	Definition										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ 13										
9:0	Reserved.										

SMIXC4 SmiControl9

This register specifies the control mechanism for SMI sources in [SMIX90](#)[31:16].

Bits	Description
31:26	Reserved.
25:24	Smicontrol156. Read-write. Reset: 0. Control for configuration cycle trapping 0. See: Smicontrol144.
23:18	Reserved.
17:16	Smicontrol152. Read-write. Reset: 0. Control for memory trapping 0. See: Smicontrol144.
15:10	Reserved.
9:8	Smicontrol148. Read-write. Reset: 0. Control for IO trapping 0. See: Smicontrol144.
7:6	Reserved.
5:4	Reserved.

3:2	Smicontrol145 . Read-write. Reset: 0. Control for soft reset request. See: Smicontrol144.										
1:0	Smicontrol144 . Read-write. Reset: 0. Control for AB SMI trapping request.										
	<table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Disable</td></tr> <tr> <td>01b</td><td>SMI</td></tr> <tr> <td>10b</td><td>NMI</td></tr> <tr> <td>11b</td><td>IRQ13</td></tr> </table>	Bits	Definition	00b	Disable	01b	SMI	10b	NMI	11b	IRQ13
Bits	Definition										
00b	Disable										
01b	SMI										
10b	NMI										
11b	IRQ13										

SMIxC8 IoTrapping0

Bits	Description
15:0	IoTrapping0 . Read-write. Reset: 0. Specifies the IO address which causes SMI event.

SMIxCA IoTrapping1

Bits	Description
15:0	IoTrapping1 . Read-write. Reset: 0. Specifies the IO address which causes SMI event.

SMIxCC IoTrapping2

Bits	Description
15:0	IoTrapping2 . Read-write. Reset: 0. Specifies the IO address which causes SMI event.

SMIxCE IoTrapping3

Bits	Description
15:0	IoTrapping3 . Read-write. Reset: 0. Specifies the IO address which causes SMI event.

SMIxD0 MemTrapping0

Bits	Description
31:2	MemTrapping . Read-write. Reset: 0. Specifies the 30-bit memory address which causes SMI event. The lowest 2 bits are ignored.
1	MemRdOvrEn . Read-write. Reset: 0. 1=Force read data to be replaced by SMIxD4 [MemRdOvrData0] .
0	MemTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified by [Mem-Trapping]. 1=Trap on write access.

SMIxD4 MemRdOvrData0

Bits	Description
31:0	MemRdOvrData . Read-write. Reset: 0. This 32-bit data is used as the return data when the memory read trapping is enabled through SMIxD0 [MemRdOvrEn].

SMIxD8 MemTrapping1

Bits	Description
31:2	MemTrapping . Read-write. Reset: 0. Specifies the 30-bit memory address which causes SMI event. The lowest 2 bits are ignored.
1	MemRdOvrEn . Read-write. Reset: 0. 1=Force read data to be replaced by SMIxDC [MemRdOvrData1].
0	MemTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified by [Mem-Trapping]. 1=Trap on write access.

SMIxDC MemRdOvrData1

Bits	Description
31:0	MemRdOvrData . Read-write. Reset: 0. This 32-bit data is used as the return data when the memory read trapping is enabled through SMIxD8 [MemRdOvrEn].

SMIxE0 MemTrapping2

Bits	Description
31:2	MemTrapping . Read-write. Reset: 0. Specifies the 30-bit memory address which causes SMI event. The lowest 2 bits are ignored.
1	MemRdOvrEn . Read-write. Reset: 0. 1=Force read data to be replaced by SMIxE4 [MemRdOvrData2].
0	MemTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified by [Mem-Trapping]. 1=Trap on write access.

SMIxE4 MemRdOvrData2

Bits	Description
31:0	MemRdOvrData . Read-write. Reset: 0. This 32-bit data is used as the return data when the memory read trapping is enabled through SMIxE0 [MemRdOvrEn].

SMIxE8 MemTrapping3

Bits	Description
31:2	MemTrapping . Read-write. Reset: 0. Specifies the 30-bit memory address which causes SMI event. The lowest 2 bits are ignored.
1	MemRdOvrEn . Read-write. Reset: 0. 1=Force read data to be replaced by SMIxEC [MemRdOvrData3].
0	MemTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified by [MemTrapping]. 1=Trap on write access.

SMIxEC MemRdOvrData3

Bits	Description
31:0	MemRdOvrData . Read-write. Reset: 0. This 32-bit data is used as the return data when the memory read trapping is enabled through SMIxE8 [MemRdOvrEn].

SMIxF0 CfgTrapping0

Bits	Description
31:2	CfgTrapping . Read-write. Reset: 0. Specifies the AD[31:2] value during configure cycle which causes SMI event.
1	IoTrappingRw0 . Read-write. Reset: 0. 0=Trap on IO read access on the address specified in SMIxC8 [IoTrapping0]. 1=Trap on IO write access on the address specified in SMIxC8 [IoTrapping0].
0	CfgTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified in [CfgTrapping]. 1=Trap on write access.

SMIxF4 CfgTrapping1

Bits	Description
31:2	CfgTrapping . Read-write. Reset: 0. Specifies the AD[31:2] value during configure cycle which causes SMI event.
1	IoTrappingRw1 . Read-write. Reset: 0. 0=Trap on IO read access on the address specified in SMIxCA [IoTrapping1]. 1=Trap on IO write access on the address specified in SMIxCA [IoTrapping1].
0	CfgTrappingRw . Read-write. Reset: 0. 0=Trap on read access at the address specified in [CfgTrapping]. 1=Trap on write access.

SMIxF8 CfgTrapping2

Bits	Description
31:2	CfgTrapping . Read-write. Reset: 0. Specifies the AD[31:2] value during configure cycle which causes SMI event.

1	IoTrappingRw2. Read-write. Reset: 0. 0=Trap on IO read access on the address specified in SMIxCC [IoTrapping2] . 1=Trap on IO write access on the address specified in SMIxCC [IoTrapping2] .
0	CfgTrappingRw. Read-write. Reset: 0. 0=Trap on read access at the address specified in [CfgTrapping]. 1=Trap on write access.

SMIxFC CfgTrapping3

Bits	Description
31:2	CfgTrapping. Read-write. Reset: 0. Specifies the AD[31:2] value during configure cycle which causes SMI event.
1	IoTrappingRw3. Read-write. Reset: 0. 0=Trap on IO read access at the address specified in SMIxCE [IoTrapping3] . 1=Trap on IO write access at the address specified in SMIxCE [IoTrapping3] .
0	CfgTrappingRw. Read-write. Reset: 0. 0=Trap on read access at the address specified in [CfgTrapping]. 1=Trap on write access.

3.26.17 Watchdog Timer (WDT) Registers

Watchdog timer registers are accessed through two methods:

- Memory access to Watchdog Timer memory address range from FEB0_0000h to FEB0_000Fh. Program [PMx00](#)[WatchdogTmrEn]=1 to enable Watchdog Timer decoding.
- Memory mapped access through the AcpiMmio region. The Watchdog Timer registers start from FED8_0000h+B00h. See [PMx04](#)[MmioEn].

WDTx00 WatchdogControl

Bits	Description
31:8	Reserved.
7	WatchdogTrigger. IF (!WatchdogDisable && WatchdogRunStopB) THEN RAZ; write-1-only. ELSE RAZ. ENDIF. Reset: 0. Writing 1 to this bit triggers the watchdog to start a new count interval, counting down from the value that was last written to WDTx04 .
6:4	Reserved.
3	WatchdogDisable. Read-only. Reset: 1. This bit reflects the state of the watchdog timer hardware. 0=Enable. 1=Disable.
2	WatchdogAction. Read-write. Reset: 0. This bit determines the action to be taken when the watchdog timer expires. 0=System reset. 1=System power off. The bit is only valid when the watchdog is enabled.
1	WatchdogFired. Read; write-1-to-clear. Cold reset: 0. 1=The watchdog timer has expired and caused the current restart. The bit is cleared by a power cycle or by the operating system and it must remain cleared for any restart that is not caused by the watchdog timer firing. The bit is only valid when the watchdog is enabled.
0	WatchdogRunStopB. Read-write. Reset: 0. 1=Watchdog is in the running state. 0=Watchdog is in the stopped state. This bit is used to control or indicate whether the watchdog is in the running or stopped states. If the watchdog is in the stopped state and a 1 is written to this bit, the watchdog moves to the running state, but a count interval is not started until a 1 is written to WatchdogTrigger. If the watchdog is in the running state, writing 1 to this bit has no effect. The bit is only valid when the watchdog is enabled.

WDTx04 WatchdogCount

Bits	Description
31:16	Reserved.
15:0	WatchdogCount. Read-write. Reset: X. Writing this field specifies the countdown time for the counter.

3.26.18 Wake Alarm Device (AcDcTimer) Registers

The AC/DC timer registers are used to control the wake alarm device. They are accessed through the AcpiMmio region. The AC DC timer registers range from FED8_0000h+1D00h to FED8_0000h+1DFFh. See [PMx04](#)[MmioEn].

AcDcTimerx00 AcTimerValue

Bits	Description								
31:0	<p>AcTimerValue. Read-write; updated-by-hardware. Reset: FFFF_FFFFh. Writing the register with a value other than FFFF_FFFFh starts the AC timer. Reading this register returns the current value of the AC timer.</p> <p>When the AC or DC timer generates a wake up event, this register is reset to FFFF_FFFFh by hardware.</p> <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>FFFF_FFFFh</td><td>Disable the AC timer.</td></tr> <tr> <td>FFFF_FFFEh-0000_0001h</td><td>The value indicates the number of seconds between the time when the AC timer is programmed and the time when it expires.</td></tr> <tr> <td>0000_0000h</td><td>The AC timer wakes up the system instantly.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	FFFF_FFFFh	Disable the AC timer.	FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the AC timer is programmed and the time when it expires.	0000_0000h	The AC timer wakes up the system instantly.
<u>Bits</u>	<u>Definition</u>								
FFFF_FFFFh	Disable the AC timer.								
FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the AC timer is programmed and the time when it expires.								
0000_0000h	The AC timer wakes up the system instantly.								

AcDcTimerx04 AcExpiredTimerPolicy

Bits	Description								
31:0	<p>AcExpiredTimerPolicy. Read-write; updated-by-hardware. Reset: FFFF_FFFFh. When the AC timer expires, the wake signal is asserted if the current power source is AC; the wake signal is not asserted if the current power source is DC. If the power source is switched from DC to AC after the AC timer expired, we wait for the number of seconds defined in this register and then wake up the system. When the AC or DC timer generates a wake up event, this register is reset to FFFF_FFFFh by hardware.</p> <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>FFFF_FFFFh</td><td>Disable the AC expired timer policy.</td></tr> <tr> <td>FFFF_FFFEh-0000_0001h</td><td>The value indicates the number of seconds between the time when the power is switched to AC and the time when it generates the wake-up event.</td></tr> <tr> <td>0000_0000h</td><td>The expired AC timer wakes up the system instantly once the power source is switched to AC.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	FFFF_FFFFh	Disable the AC expired timer policy.	FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the power is switched to AC and the time when it generates the wake-up event.	0000_0000h	The expired AC timer wakes up the system instantly once the power source is switched to AC.
<u>Bits</u>	<u>Definition</u>								
FFFF_FFFFh	Disable the AC expired timer policy.								
FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the power is switched to AC and the time when it generates the wake-up event.								
0000_0000h	The expired AC timer wakes up the system instantly once the power source is switched to AC.								

AcDcTimerx08 AcTimerStatus

Bits	Description
31:2	Reserved.
1	AcTimerWakeup. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Wake up was caused by AC timer expiration. 0=Wake-up was not caused by AC timer expiration.
0	AcTimerExpired. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=AC timer expired. 0=AC timer has not expired.

AcDcTimerx10 DcTimerValue

Bits	Description								
31:0	<p>DcTimerValue. Read-write; updated-by-hardware. Reset: FFFF_FFFFh. Writing the register with a value other than FFFF_FFFFh starts the DC timer. Reading this register returns the current value of the DC timer.</p> <p>When the AC or DC Timer generates a wake up event, this register is reset to FFFF_FFFFh by hardware.</p> <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>FFFF_FFFFh</td><td>Disable the DC timer.</td></tr> <tr> <td>FFFF_FFFEh-0000_0001h</td><td>The value indicates the number of seconds between the time when the DC timer is programmed and the time when it expires.</td></tr> <tr> <td>0000_0000h</td><td>The DC timer wakes up the system instantly.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	FFFF_FFFFh	Disable the DC timer.	FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the DC timer is programmed and the time when it expires.	0000_0000h	The DC timer wakes up the system instantly.
<u>Bits</u>	<u>Definition</u>								
FFFF_FFFFh	Disable the DC timer.								
FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the DC timer is programmed and the time when it expires.								
0000_0000h	The DC timer wakes up the system instantly.								

AcDcTimerx14 DcExpiredTimerPolicy

Bits	Description								
31:0	<p>DcExpiredTimerPolicy. Read-write; updated-by-hardware. Reset: FFFF_FFFFh. When the DC timer expires, the wake signal is asserted if the current power source is DC; the wake signal is not asserted if the current power source is AC. If the power source is switched from AC to DC after the DC timer expired, we wait for the number of seconds defined in this register and then wake up the system. When the AC or DC timer generates a wake up event, this register is reset to FFFF_FFFFh by hardware.</p> <table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>FFFF_FFFFh</td><td>Disable the DC expired timer policy.</td></tr> <tr> <td>FFFF_FFFEh-0000_0001h</td><td>The value indicates the number of seconds between the time when the power is switched to DC and the time when it generates the wake-up event.</td></tr> <tr> <td>0000_0000h</td><td>The expired DC timer wakes up the system instantly once the power source is switched to DC.</td></tr> </table>	<u>Bits</u>	<u>Definition</u>	FFFF_FFFFh	Disable the DC expired timer policy.	FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the power is switched to DC and the time when it generates the wake-up event.	0000_0000h	The expired DC timer wakes up the system instantly once the power source is switched to DC.
<u>Bits</u>	<u>Definition</u>								
FFFF_FFFFh	Disable the DC expired timer policy.								
FFFF_FFFEh-0000_0001h	The value indicates the number of seconds between the time when the power is switched to DC and the time when it generates the wake-up event.								
0000_0000h	The expired DC timer wakes up the system instantly once the power source is switched to DC.								

AcDcTimerx18 DcTimerStatus

Bits	Description
31:2	Reserved.
1	DcTimerWakeup. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=Wake-up was caused by DC timer expiration. 0=Wake-up was not caused by DC timer expiration.
0	DcTimerExpired. Read; set-by-hardware; write-1-to-clear. Reset: 0. 1=DC timer expired. 0=DC timer has not expired.

AcDcTimerx20 AcDcTimerCtrl

Bits	Description
31:13	Reserved.

12	Reserved.
11:10	Reserved.
9	DcTimerEventEn. Read-write. Reset: 0. 1=Enable DC Timer to wake up system. 0=Disable.
8	AcTimerEventEn. Read-write. Reset: 0. 1=Enable AC Timer to wake up system. 0=Disable.
7:1	Reserved.
0	Busy. Read-only; updated-by-hardware. Reset: 0h. Right after AcDcTimerx00 [AcTimerValue] or AcDcTimerx10 [DcTimerValue] is programmed, the hardware sets this bit to 1. The hardware will clear this bit once the programming is done and the corresponding timer is started properly. Before the software writes to AcDcTimerx00 [AcTimerValue] or AcDcTimerx10 [DcTimerValue] , it has to read this bit and make sure it is 0. Otherwise, the hardware will just ignore the programming action from software. For the registers other than AcDcTimerx00 [AcTimerValue] or AcDcTimerx10 [DcTimerValue] , there is no such limitation.

4 Register List

The following is a list of all storage elements, context, and registers provided in this document. Page numbers, register mnemonics, and register names are provided.

47	SMMFEC0: SMM IO Trap Offset	206	D0F0x98_x3A: ORB Source Tag Translation Control 2
47	SMMFEC4: Local SMI Status	206	D0F0x98_x3B: ORB Source Tag Translation Control 3
47	SMMFEC8: SMM IO Restart Byte	206	D0F0x98_x4[A,9]: ORB LCLK Clock Control 1-0
48	SMMFEC9: Auto Halt Restart Offset	207	D0F0xB8: SMU Index Address
48	SMMFECA: NMI Mask	207	D0F0xBC: SMU Index Data
48	SMMFED8: SMM SVM State	207	D0F0xBC_x3F800: FIRMWARE_FLAGS
49	SMMFEFC: SMM-Revision Identifier	207	D0F0xBC_x3F804: FIRMWARE_VID
49	SMMFF00: SMM Base Address (SMM_BASE)	207	D0F0xBC_x3F820: PM_INTERVAL_CNTL_0
118	MR0: DDR3 MR0	208	D0F0xBC_x3F828: PM_TIMER_PERIOD
120	MR1: DDR3 MR1	208	D0F0xBC_x3F9D8: PM_CONFIG
120	MR2: DDR3 MR2	209	D0F0xBC_x3F9E8: NB_DPM_CONFIG_1
121	MR3: DDR3 MR3	209	D0F0xBC_x3F9EC: NB_DPM_CONFIG_2
192	IOCF8: IO-Space Configuration Address	209	D0F0xBC_x3F9F4: CSR_GNB_1
193	IOCF8: IO-Space Configuration Data Port	210	D0F0xBC_x3F9F8: CSR_GNB_3
194	D0F0x00: Device/Vendor ID	210	D0F0xBC_x3FD[8C:00:step14]: LCLK DPM Control 0
194	D0F0x04: Status/Command	210	D0F0xBC_x3FD[94:08:step14]: LCLK DPM Control 2
194	D0F0x08: Class Code/Revision ID	211	D0F0xBC_x3FD[9C:10:step14]: LCLK DPM Activity Thresholds
194	D0F0x0C: Header Type	211	D0F0xBC_x3FDC8: SMU_LCLK_DPM_CNTL
195	D0F0x2C: Subsystem and Subvendor ID	211	D0F0xBC_x3FDD0: SMU_LCLK_DPM_THERMAL_THROTTLING_CNTL
195	D0F0x34: Capabilities Pointer	211	D0F0xBC_x3FDD4: SMU_LCLK_DPM_THERMAL_THROTTLING_THRESHOLDS
195	D0F0x48: NB Header Write Register	212	D0F0xBC_xC020_008C: LCLK_DEEP_SLEEP_CNTL
195	D0F0x4C: PCI Control	212	D0F0xBC_xC020_0098: CONNECTED_STANDBY_CONTROL
196	D0F0x60: Miscellaneous Index	212	D0F0xBC_xC020_0110: Activity Monitor Control
196	D0F0x64: Miscellaneous Index Data	213	D0F0xBC_xC210_0000: CPU Interrupt Request
196	D0F0x64_x00: Northbridge Control	213	D0F0xBC_xC210_0004: CPU Interrupt Status
196	D0F0x64_x0C: IOC Bridge Control	213	D0F0xBC_xC210_003C: CPU Interrupt Argument
196	D0F0x64_x0D: IOC PCI Configuration	213	D0F0xBC_xC210_0040: CPU Interrupt Response
197	D0F0x64_x16: IOC Advanced Error Reporting Control	213	D0F0xC8: DEV Index Address
197	D0F0x64_x17: Memory Mapped IO Base Address	214	D0F0xCC: DEV Index Data
197	D0F0x64_x18: Memory Mapped IO Limit	214	D0F0xCC_x01_ib[15:11]: IOC Bridge Control
197	D0F0x64_x19: Top of Memory 2 Low	214	D0F0xD0: GBIF Index Address
197	D0F0x64_x1A: Top of Memory 2 High	214	D0F0xD4: GBIF Index Data
198	D0F0x64_x1D: Internal Graphics PCI Control	215	D0F0xD4_x0109_14E1: CC Bif Bx Strap0 Ind
198	D0F0x64_x1F: FCH Location	215	D0F0xD4_x0109_14E2: CC Bif Bx Strap1 Ind
198	D0F0x64_x22: LCLK Control 0	216	D0F0xD4_x0109_1507: CC Bif Bx Pinstrap0 Ind
199	D0F0x64_x23: LCLK Control 1	216	D0F0xE0: Link Index Address
199	D0F0x64_x3[4:0]: Programmable Device Remap Register	217	D0F0xE4: Link Index Data
200	D0F0x64_x46: IOC Features Control	217	D0F0xE4_x0110_0010: PIF Control
200	D0F0x7C: IOC Configuration Control	217	D0F0xE4_x0110_0011: PIF Pairing
200	D0F0x84: Link Arbitration	218	D0F0xE4_x0110_001[8:7,3:2]: PIF Power Down Control [3:0]
201	D0F0x90: Northbridge Top of Memory	220	D0F0xE4_x0120_0004: Phy Global Control 0
201	D0F0x94: Northbridge ORB Configuration Offset	220	D0F0xE4_x0120_4440: Phy RO PLL Control
201	D0F0x98: Northbridge ORB Configuration Data Port	220	D0F0xE4_x0120_4450: PhyRO PLL Override Control 0
201	D0F0x98_x02: ORB PGMEM Control	221	D0F0xE4_x0130_0046: Subsystem and Vendor ID
202	D0F0x98_x06: ORB Downstream Control 0	221	D0F0xE4_x0130_0080: Link Configuration
202	D0F0x98_x07: ORB Upstream Arbitration Control 0	221	D0F0xE4_x0130_0[C:8]00: Link Hold Training Control
202	D0F0x98_x08: ORB Upstream Arbitration Control 1	222	D0F0xE4_x0130_0[C:8]03: Link Deemphasis Control
203	D0F0x98_x09: ORB Upstream Arbitration Control 2	222	D0F0xE4_x0130_0[C:8]04: Link AER Control
203	D0F0x98_x0C: ORB Upstream Arbitration Control 5	222	D0F0xE4_x0130_0[C:8]05: Link Training Control
204	D0F0x98_x1E: ORB Receive Control 0	223	D0F0xE4_x0130_8002: IO Link Wrapper Scratch
204	D0F0x98_x26: ORB IOMMU Control 0	223	D0F0xE4_x0130_8011: Link Transmit Clock Gating Control
204	D0F0x98_x27: ORB IOMMU Control 1	223	D0F0xE4_x0130_8012: Link Idle-Resume Clock Gating Control
205	D0F0x98_x28: ORB Transmit Control 0	224	D0F0xE4_x0130_8013: Transmit Clock PII Control
205	D0F0x98_x29: ORB Transmit Status	224	D0F0xE4_x0130_8014: Link Transmit Clock Gating Control 2
205	D0F0x98_x2C: ORB Clock Control	225	D0F0xE4_x0130_8015: IO Link IOC Control
205	D0F0x98_x37: ORB Allow LDTSTOP Control 0	225	D0F0xE4_x0130_8016: Link Clock Switching Control
		226	D0F0xE4_x0130_802[4:1]: Transmitter Lane Mux
		227	D0F0xE4_x0130_802[8:5]: Receiver Lane Mux
		228	D0F0xE4_x0130_8029: Lane Enable
		228	D0F0xE4_x0130_8060: Soft Reset Command 0
		228	D0F0xE4_x0130_8062: Soft Reset Control 0

229	D0F0xE4_x0130_80F0: BIOS Timer	249	D0F2xF4_x1C: L2_PTC_B_CONTROL
229	D0F0xE4_x0130_80F1: BIOS Timer Control	249	D0F2xF4_x1D: L2_PTC_B_HASH_CONTROL
229	D0F0xE4_x0140_0002: IO Link Hardware Debug	250	D0F2xF4_x1E: L2_PTC_B_WAY_CONTROL
229	D0F0xE4_x0140_0010: IO Link Control 1	250	D0F2xF4_x20: L2_CREDIT_CONTROL_2
230	D0F0xE4_x0140_0011: IO Link Config Control	250	D0F2xF4_x22: L2A_UPDATE_FILTER_CNTL
230	D0F0xE4_x0140_001C: IO Link Control 2	251	D0F2xF4_x30: L2_ERR_RULE_CONTROL_3
231	D0F0xE4_x0140_0020: IO Link Chip Interface Control	251	D0F2xF4_x31: L2_ERR_RULE_CONTROL_4
231	D0F0xE4_x0140_0040: IO Link Phy Control	251	D0F2xF4_x32: L2_ERR_RULE_CONTROL_5
231	D0F0xE4_x0140_00B0: IO Link Strap Control	251	D0F2xF4_x33: L2_L2A_CK_GATE_CONTROL
231	D0F0xE4_x0140_00C0: IO Link Strap Miscellaneous	252	D0F2xF4_x34: L2_L2A_PGFSIZE_CONTROL
232	D0F0xE4_x0140_00C1: IO Link Strap Miscellaneous2	252	D0F2xF4_x3B: IOMMU_PGFSM_CONFIG
232	D0F0xF8: Northbridge IOAPIC Index	252	D0F2xF4_x3C: IOMMU_PGFSM_WRITE
232	D0F0xFC: Northbridge IOAPIC Data	252	D0F2xF4_x3D: IOMMU_PGFSM_READ
232	D0F0xFC_x00: IOAPIC Feature Control Register	253	D0F2xF4_x40: L2_PERF_CNTL_2
233	D0F0xFC_x01: IOAPIC Base Address Lower	253	D0F2xF4_x41: L2_PERF_COUNT_4
233	D0F0xFC_x02: IOAPIC Base Address Upper	253	D0F2xF4_x42: L2_PERF_COUNT_5
233	D0F0xFC_x0F: IOAPIC GBIF Interrupt Routing Register	253	D0F2xF4_x43: L2_PERF_CNTL_3
233	D0F0xFC_x1[4:0]: IOAPIC BR Interrupt Routing Register	253	D0F2xF4_x44: L2_PERF_COUNT_6
234	D0F0xFC_x30: IOAPIC SPG Interrupt Routing Register	253	D0F2xF4_x45: L2_PERF_COUNT_7
234	D0F0xFC_x31: IOAPIC Serial IRQ Status	254	D0F2xF4_x48: L2_STATUS_1
234	D0F0xFC_x3[F:E]: IOAPIC Scratch [1:0] Register	254	D0F2xF4_x49: L2_SB_LOCATION
235	D0F2x00: Device/Vendor ID	254	D0F2xF4_x4C: L2_CONTROL_5
235	D0F2x04: Status/Command	255	D0F2xF4_x4D: L2_CONTROL_6
236	D0F2x08: Class Code/Revision ID	255	D0F2xF4_x50: L2_PDC_CONTROL
236	D0F2x0C: Header Type	256	D0F2xF4_x51: L2_PDC_HASH_CONTROL
236	D0F2x2C: Subsystem and Subvendor ID	256	D0F2xF4_x52: L2_PDC_WAY_CONTROL
236	D0F2x34: Capabilities Pointer	257	D0F2xF4_x53: L2B_UPDATE_FILTER_CNTL
236	D0F2x3C: Interrupt Line	257	D0F2xF4_x54: L2_TW_CONTROL
237	D0F2x40: IOMMU Capability	257	D0F2xF4_x56: L2_CP_CONTROL
237	D0F2x44: IOMMU Base Address Low	258	D0F2xF4_x57: L2_CP_CONTROL_1
238	D0F2x48: IOMMU Base Address High	258	D0F2xF4_x58: IOMMU_L2_GUEST_ADDR_CNTRL
238	D0F2x4C: IOMMU Range	258	D0F2xF4_x6A: L2_INT_CONTROL
238	D0F2x50: IOMMU Miscellaneous Information Register	258	D0F2xF4_x70: L2_CREDIT_CONTROL_0
239	D0F2x54: IOMMU Miscellaneous Information Register High	259	D0F2xF4_x71: L2_CREDIT_CONTROL_1
239	D0F2x64: IOMMU MSI Capability Register	259	D0F2xF4_x78: L2_MCIF_CONTROL
240	D0F2x68: IOMMU MSI Address Low	260	D0F2xF4_x80: L2_ERR_RULE_CONTROL_0
240	D0F2x6C: IOMMU MSI Address High	260	D0F2xF4_x81: L2_ERR_RULE_CONTROL_1
240	D0F2x70: IOMMU MSI Data	260	D0F2xF4_x82: L2_ERR_RULE_CONTROL_2
240	D0F2x74: IOMMU MSI Mapping Capability	260	D0F2xF4_x90: L2_L2B_CK_GATE_CONTROL
241	D0F2x7C: IOMMU Control	261	D0F2xF4_x92: PPR_CONTROL
241	D0F2x80: IOMMU MMIO Control Low	261	D0F2xF4_x94: L2_L2B_PGFSIZE_CONTROL
241	D0F2x84: IOMMU MMIO Control High	261	D0F2xF8: IOMMU L1 Config Index
241	D0F2x88: IOMMU Range Control	262	D0F2xFC: IOMMU L1 Config Data
242	D0F2xF0: IOMMU L2 Config Index	262	D0F2xFC_x00_L1i[4:0]: L1_PERF_CNTL
242	D0F2xF4: IOMMU L2 Config Data	262	D0F2xFC_x01_L1i[4:0]: L1_PERF_COUNT_0
242	D0F2xF4_x00: L2_PERF_CNTL_0	262	D0F2xFC_x02_L1i[4:0]: L1_PERF_COUNT_1
242	D0F2xF4_x01: L2_PERF_COUNT_0	262	D0F2xFC_x07_L1i[4:0]: L1_DEBUG_1
243	D0F2xF4_x02: L2_PERF_COUNT_1	263	D0F2xFC_x09_L1i[4:0]: L1_SB_LOCATION
243	D0F2xF4_x03: L2_PERF_CNTL_1	263	D0F2xFC_x0C_L1i[4:0]: L1_CNTRL_0
243	D0F2xF4_x04: L2_PERF_COUNT_2	264	D0F2xFC_x0D_L1i[4:0]: L1_CNTRL_1
243	D0F2xF4_x05: L2_PERF_COUNT_3	264	D0F2xFC_x0E_L1i[4:0]: L1_CNTRL_2
243	D0F2xF4_x08: L2_STATUS_0	265	D0F2xFC_x0F_L1i[4:0]: L1_CNTRL_3
243	D0F2xF4_x0C: L2_CONTROL_0	265	D0F2xFC_x10_L1i[4:0]: L1_BANK_SEL_0
244	D0F2xF4_x0D: L2_CONTROL_1	265	D0F2xFC_x11_L1i[4:0]: L1_BANK_DISABLE_0
245	D0F2xF4_x10: L2_DTC_CONTROL	266	D0F2xFC_x20_L1i[4:0]: L1_WQ_STATUS_0
245	D0F2xF4_x11: L2_DTC_HASH_CONTROL	266	D0F2xFC_x21_L1i[4:0]: L1_WQ_STATUS_1
246	D0F2xF4_x12: L2_DTC_WAY_CONTROL	267	D0F2xFC_x22_L1i[4:0]: L1_WQ_STATUS_2
246	D0F2xF4_x14: L2_ITC_CONTROL	267	D0F2xFC_x23_L1i[4:0]: L1_WQ_STATUS_3
247	D0F2xF4_x15: L2_ITC_HASH_CONTROL	267	D0F2xFC_x32_L1i[4:0]: L1_CNTRL_4
247	D0F2xF4_x16: L2_ITC_WAY_CONTROL	268	D0F2xFC_x33_L1i[4:0]: L1_CLKCNTRL_0
247	D0F2xF4_x18: L2_PTC_A_CONTROL	268	D0F2xFC_x34_L1i[4:0]: L1_MEMPWRCNTRL_0
248	D0F2xF4_x19: L2_PTC_A_HASH_CONTROL	268	D0F2xFC_x35_L1i[4:0]: L1_MEMPWRCNTRL_1
248	D0F2xF4_x1A: L2_PTC_A_WAY_CONTROL	268	D0F2xFC_x36_L1i[4:0]: L1_GUEST_ADDR_CNTRL

269	D0F2xFC_x37_L1i[4:0]: L1_FEATURE_SUP_CNTRL	290	D1F1x80: Device Control and Status 2
269	D0F2xFC_x38_L1i[4:0]: L1_CNTRL_5	291	D1F1x84: Link Capability 2
269	D0F2xFC_x39_L1i[4:0]: L1_PGMEM_CNTRL1	291	D1F1x88: Link Control and Status 2
270	D0F2xFC_x3A_L1i[4:0]: L1_PGMEM_CNTRL2	291	D1F1xA0: MSI Capability
270	D0F2xFC_x3B_L1i[4:0]: L1_PGMEM_CNTRL3	292	D1F1xA4: MSI Message Address Low
270	D0F2xFC_x3C_L1i[4:0]: L1_PGMEM_CNTRL4	292	D1F1xA8: MSI Message Address High
271	D1F0x00: Device/Vendor ID	292	D1F1xAC: MSI Message Data
271	D1F0x04: Status/Command Register	292	D1F1x100: Vendor Specific Enhanced Capability
272	D1F0x08: Class Code/Revision ID Register	292	D1F1x104: Vendor Specific Header
272	D1F0x0C: Header Type Register	293	D1F1x108: Vendor Specific 1
272	D1F0x10: Graphic Memory Base Address	293	D1F1x10C: Vendor Specific 2
273	D1F0x14: Graphics Memory Base Address 64	294	D2F0x00: Device/Vendor ID (Host Bridge)
273	D1F0x18: Graphics Doorbell Base Address	294	D2F0x04: Status/Command
273	D1F0x1C: Graphics Doorbell Base Address 64	294	D2F0x08: Class Code/Revision ID
273	D1F0x20: Graphics IO Base Address	294	D2F0x0C: Header Type
274	D1F0x24: Graphics Memory Mapped Registers Base Address	295	D2F0x40: Header Type Write
274	D1F0x2C: Subsystem and Subvendor ID Register	295	D2F[5:1]x00: Device/Vendor ID
274	D1F0x30: Expansion ROM Base Address	295	D2F[5:1]x04: Status/Command Register
274	D1F0x34: Capabilities Pointer	296	D2F[5:1]x08: Class Code/Revision ID Register
274	D1F0x3C: Interrupt Line	296	D2F[5:1]x0C: Header Type Register
275	D1F0x4C: Subsystem and Subvendor ID Mirror	297	D2F[5:1]x18: Bus Number and Secondary Latency Register
275	D1F0x50: Power Management Capability	297	D2F[5:1]x1C: IO Base and Secondary Status Register
275	D1F0x54: Power Management Control and Status	298	D2F[5:1]x20: Memory Limit and Base Register
276	D1F0x58: PCI Express Capability	298	D2F[5:1]x24: Prefetchable Memory Limit and Base Register
276	D1F0x5C: Device Capability	298	D2F[5:1]x28: Prefetchable Memory Base High Register
276	D1F0x60: Device Control and Status	298	D2F[5:1]x2C: Prefetchable Memory Limit High Register
277	D1F0x64: Link Capability	298	D2F[5:1]x30: IO Base and Limit High Register
278	D1F0x68: Link Control and Status	299	D2F[5:1]x34: Capabilities Pointer Register
279	D1F0x7C: Device Capability 2	299	D2F[5:1]x3C: Bridge Control Register
279	D1F0x80: Device Control and Status 2	299	D2F[5:1]x50: Power Management Capability Register
280	D1F0x84: Link Capability 2	300	D2F[5:1]x54: Power Management Control and Status Register
280	D1F0x88: Link Control and Status 2	300	D2F[5:1]x58: PCI Express Capability Register
280	D1F0xA0: MSI Capability	301	D2F[5:1]x5C: Device Capability Register
281	D1F0xA4: MSI Message Address Low	301	D2F[5:1]x60: Device Control and Status Register
281	D1F0xA8: MSI Message Address High	302	D2F[5:1]x64: IO Link Capability Register
281	D1F0xAC: MSI Message Data	303	D2F[5:1]x68: IO Link Control and Status Register
281	D1F0x100: Vendor Specific Enhanced Capability	305	D2F[5:1]x6C: Slot Capability Register
282	D1F0x104: Vendor Specific Header	306	D2F[5:1]x70: Slot Control and Status Register
282	D1F0x108: Vendor Specific 1	306	D2F[5:1]x74: Root Complex Capability and Control Register
282	D1F0x10C: Vendor Specific 2	307	D2F[5:1]x78: Root Complex Status Register
283	D1F1x00: Device/Vendor ID	307	D2F[5:1]x7C: Device Capability 2
283	D1F1x04: Status/Command	308	D2F[5:1]x80: Device Control and Status 2
284	D1F1x08: Class Code/Revision ID	309	D2F[5:1]x84: IO Link Capability 2
284	D1F1x0C: Header Type	309	D2F[5:1]x88: IO Link Control and Status 2
284	D1F1x10: Audio Registers Base Address	310	D2F[5:1]x8C: Slot Capability 2
284	D1F1x14: Base Address 1	310	D2F[5:1]x90: Slot Control and Status 2
285	D1F1x18: Base Address 2	310	D2F[5:1]xA0: MSI Capability Register
285	D1F1x1C: Base Address 3	311	D2F[5:1]xA4: MSI Message Address Low
285	D1F1x20: Base Address 4	311	D2F[5:1]xA8: MSI Message Address High
285	D1F1x24: Base Address 5	311	D2F[5:1]xAC: MSI Message Data
285	D1F1x2C: Subsystem and Subvendor ID	311	D2F[5:1]xB0: Subsystem and Subvendor Capability ID Register
285	D1F1x30: Expansion ROM Base Address	312	D2F[5:1]xB4: Subsystem and Subvendor ID Register
286	D1F1x34: Capabilities Pointer	312	D2F[5:1]xB8: MSI Capability Mapping
286	D1F1x3C: Interrupt Line	312	D2F[5:1]xBC: MSI Mapping Address Low
286	D1F1x4C: Subsystem and Subvendor ID Mirror	312	D2F[5:1]xC0: MSI Mapping Address High
286	D1F1x50: Power Management Capability	312	D2F[5:1]xE0: Root Port Index
287	D1F1x54: Power Management Control and Status	313	D2F[5:1]xE4: Root Port Data
287	D1F1x58: PCI Express Capability	313	D2F[5:1]xE4_x20: Root Port TX Control
287	D1F1x5C: Device Capability	313	D2F[5:1]xE4_x50: Root Port Lane Status
288	D1F1x60: Device Control and Status	313	D2F[5:1]xE4_x6A: Root Port Error Control
289	D1F1x64: Link Capability	313	D2F[5:1]xE4_x70: Root Port Receiver Control
289	D1F1x68: Link Control and Status	314	D2F[5:1]xE4_xA0: Per Port Link Controller (LC) Control
290	D1F1x7C: Device Capability 2	314	D2F[5:1]xE4_xA1: LC Training Control

315	D2F[5:1]xE4_xA2: LC Link Width Control	351	D18F2x00: Device/Vendor ID
315	D2F[5:1]xE4_xA3: LC Number of FTS Control	351	D18F2x08: Class Code/Revision ID
316	D2F[5:1]xE4_xA4: LC Link Speed Control	351	D18F2x0C: Header Type
316	D2F[5:1]xE4_xA5: LC State 0	351	D18F2x[5C:40]_dct[0]: DRAM CS Base Address
317	D2F[5:1]xE4_xB1: LC Control 2	353	D18F2x[6C:60]_dct[0]: DRAM CS Mask
318	D2F[5:1]xE4_xB5: LC Control 3	353	D18F2x78_dct[0]: DRAM Control
318	D2F[5:1]xE4_xC0: LC Strap Override	354	D18F2x7C_dct[0]: DRAM Initialization
318	D2F[5:1]xE4_xC1: Root Port Miscellaneous Strap Override	355	D18F2x80_dct[0]: DRAM Bank Address Mapping
319	D2F[5:1]xE4_xD0: Root Port ECC Skip OS Feature	356	D18F2x84_dct[0]: DRAM MRS
319	D2F[5:1]x100: Vendor Specific Enhanced Capability Register	357	D18F2x88_dct[0]: DRAM Timing Low
319	D2F[5:1]x104: Vendor Specific Header Register	357	D18F2x8C_dct[0]: DRAM Timing High
319	D2F[5:1]x108: Vendor Specific 1 Register	358	D18F2x90_dct[0]: DRAM Configuration Low
320	D2F[5:1]x10C: Vendor Specific 2 Register	360	D18F2x94_dct[0]: DRAM Configuration High
320	D2F[5:1]x128: Virtual Channel 0 Resource Status Register	363	D18F2x98_dct[0]: DRAM Controller Additional Data Offset
320	D2F[5:1]x150: Advanced Error Reporting Capability	363	D18F2x9C_dct[0]: DRAM Controller Additional Data Port
320	D2F[5:1]x154: Uncorrectable Error Status	364	D18F2x9C_x0000_0000_dct[0]_mp[1:0]: DRAM Output Driver Compensation Control
321	D2F[5:1]x158: Uncorrectable Error Mask	365	D18F2x9C_x0000_0[3:0]0[3:1]_dct[0]_mp[1:0]: DRAM Write Data Timing
322	D2F[5:1]x15C: Uncorrectable Error Severity	367	D18F2x9C_x0000_0004_dct[0]_mp[1:0]: DRAM Address/Command Timing Control
322	D2F[5:1]x160: Correctable Error Status	368	D18F2x9C_x0000_0[3:0]0[7:5]_dct[0]_mp[1:0]: DRAM Read DQS Timing
323	D2F[5:1]x164: Correctable Error Mask	369	D18F2x9C_x0000_0008_dct[0]_mp[1:0]: DRAM Phy Control
323	D2F[5:1]x168: Advanced Error Control	370	D18F2x9C_x0000_000B_dct[0]: DRAM Phy Status Register
324	D2F[5:1]x16C: Header Log DW0	370	D18F2x9C_x0000_000C_dct[0]: DRAM Phy Miscellaneous
324	D2F[5:1]x170: Header Log DW1	371	D18F2x9C_x0000_000D_dct[0]_mp[1:0]: DRAM Phy DLL Control
324	D2F[5:1]x174: Header Log DW2	372	D18F2x9C_x0000_00[2A:10]_dct[0]_mp[1:0]: DRAM DQS Receiver Enable Timing
324	D2F[5:1]x178: Header Log DW3	374	D18F2x9C_x0000_00[4A:30]_dct[0]_mp[1:0]: DRAM DQS Write Timing
324	D2F[5:1]x17C: Root Error Command	375	D18F2x9C_x0000_00[52:50]_dct[0]: DRAM Phase Recovery Control
325	D2F[5:1]x180: Root Error Status	376	D18F2x9C_x0D0F_0[F,8:0]02_dct[0]: Data Byte Transmit PreDriver Calibration
325	D2F[5:1]x184: Error Source ID	378	D18F2x9C_x0D0F_0[F,8:0]0[B,7,3]_dct[0]: Data Byte P0dt Configuration
326	D18F0x00: Device/Vendor ID	378	D18F2x9C_x0D0F_0[F,8:0]04_dct[0]_mp[1:0]: Data Byte Pad Configuration
326	D18F0x04: Status/Command	379	D18F2x9C_x0D0F_0[F,8:0]0[A,6]_dct[0]: Data Byte Transmit PreDriver Calibration 2
326	D18F0x08: Class Code/Revision ID	379	D18F2x9C_x0D0F_0[F,8:0]10_dct[0]_mp[1:0]: Data Byte DLL Power Management
326	D18F0x0C: Header Type	380	D18F2x9C_x0D0F_0[F,8:0]13_dct[0]_mp[1:0]: Data Byte DLL Configuration
326	D18F0x34: Capabilities Pointer	381	D18F2x9C_x0D0F_0[F,8:0]1C_dct[0]_mp[1:0]: Data Byte DLL Power Management
326	D18F0x[5C:40]: Routing Table	382	D18F2x9C_x0D0F_0[F,8:0]1E_dct[0]_mp[1:0]: Data Byte Receiver Bias Current Control
327	D18F0x60: Node ID	382	D18F2x9C_x0D0F_0[F,8:0]1F_dct[0]_mp[1:0]: Data Byte Receiver Configuration
327	D18F0x64: Unit ID	383	D18F2x9C_x0D0F_0[F,8:0]2[3:0]_dct[0]_mp[1:0]: Data Byte Rx Dqs DLL Configuration
328	D18F0x68: Link Transaction Control	385	D18F2x9C_x0D0F_0[8:0]2[9:4]_dct[0]_mp[1:0]: Data Byte DLL Configuration
329	D18F0x6C: Link Initialization Control	385	D18F2x9C_x0D0F_0[F,8:0]30_dct[0]: Data Byte DLL Configuration and Power Down
331	D18F0x[E4,C4,A4,84]: Link Control	386	D18F2x9C_x0D0F_0[F,8:0]31_dct[0]: Data Byte Fence2 Threshold
331	D18F0x[EC,CC,AC,8C]: Link Feature Capability	386	D18F2x9C_x0D0F_0[F,8:0]38_dct[0]: Data Byte DLL Control Register
332	D18F0x[F0,D0,B0,90]: Link Base Channel Buffer Count	387	D18F2x9C_x0D0F_1C00_dct[0]: Data Byte P0dt Configuration
334	D18F0x[F4,D4,B4,94]: Link Isochronous Channel Buffer Count	387	D18F2x9C_x0D0F_2[2:0]02_dct[0]: Clock Transmit PreDriver Calibration
335	D18F0x[F8,D8,B8,98]: Link Type	388	D18F2x9C_x0D0F_[C,8,2][2:0]1E_dct[0]_mp[1:0]: Phy Control
335	D18F0x[11C,118,114,110]: Link Clumping Enable	388	D18F2x9C_x0D0F_[C,8,2][2:0]1F_dct[0]: Receiver Configuration
336	D18F0x150: Link Global Retry Control		
336	D18F0x168: Extended Link Transaction Control		
336	D18F0x16C: Link Global Extended Control		
337	D18F0x[18C:170]: Link Extended Control		
337	D18F0x1A0: Link Initialization Status		
337	D18F0x1DC: Core Enable		
339	D18F1x00: Device/Vendor ID		
339	D18F1x08: Class Code/Revision ID		
339	D18F1x0C: Header Type		
339	D18F1x[17C:140,7C:40]: DRAM Base/Limit		
341	D18F1x[2CC:2A0,1CC:180,BC:80]: MMIO Base/Limit		
343	D18F1x[DC:C0]: IO-Space Base/Limit		
345	D18F1x[1DC:1D0,EC:E0]: Configuration Map		
346	D18F1xF0: DRAM Hole Address		
346	D18F1xF4: VGA Enable		
347	D18F1x10C: DCT Configuration Select		
348	D18F1x120: DRAM Base System Address		
348	D18F1x124: DRAM Limit System Address		
349	D18F1x2[1C:00]: DRAM Controller Base/Limit		

389	D18F2x9C_x0D0F_[C,8,2][2:0]20_dct[0]_mp[1:0]: DLL Delay and Configuration	425	D18F2x264_dct[0]: DRAM Status 0
390	D18F2x9C_x0D0F_2[F,2:0]30_dct[0]: Clock DLL Configuration and Power Down	426	D18F2x268_dct[0]: DRAM Status 1
390	D18F2x9C_x0D0F_4006_dct[0]: DRAM Phy MemVref Observation Configuration	426	D18F2x26C_dct[0]: DRAM Status 2
390	D18F2x9C_x0D0F_4007_dct[0]: DRAM Phy MemVref Configuration	427	D18F2x270_dct[0]: DRAM PRBS
391	D18F2x9C_x0D0F_4009_dct[0]: Phy Cmp Configuration	427	D18F2x274_dct[0]: DRAM DQ Mask Low
391	D18F2x9C_x0D0F_[C,8][1:0]02_dct[0]: Transmit PreDriver Calibration	427	D18F2x278_dct[0]: DRAM DQ Mask High
392	D18F2x9C_x0D0F_[C,8][1:0][12,0E,0A,06]_dct[0]: Transmit PreDriver Calibration 2	427	D18F2x27C_dct[0]: DRAM ECC and EDC Mask
392	D18F2x9C_x0D0F_812F_dct[0]: Tristate Configuration	428	D18F2x280_dct[0]: DRAM DQ Pattern Override 0
393	D18F2x9C_x0D0F_[C,8][F:0]30_dct[0]: Cmd/Addr DLL Configuration and Power Down	428	D18F2x284_dct[0]: DRAM DQ Pattern Override 1
393	D18F2x9C_x0D0F_C021_dct[0]_mp[1:0]: DLL Delay and Configuration	428	D18F2x288_dct[0]: DRAM DQ Pattern Override 2
393	D18F2x9C_x0D0F_E000_dct[0]_mp[1:0]: Phy Master Configuration	429	D18F2x28C_dct[0]: DRAM Command 2
394	D18F2x9C_x0D0F_E006_dct[0]: Phy PLL Lock Time	429	D18F2x290_dct[0]: DRAM Status 3
394	D18F2x9C_x0D0F_E007_dct[0]: Phy DLL Lock Time	430	D18F2x294_dct[0]: DRAM Status 4
394	D18F2x9C_x0D00_E008_dct[0]: Phy Master Configuration	430	D18F2x298_dct[0]: DRAM Status 5
395	D18F2x9C_x0D04_E008_dct[0]: Phy Master Configuration	430	D18F2x29C_dct[0]: DRAM Status 6
395	D18F2x9C_x0D0F_E00A_dct[0]: Phy Dynamic Power Mode	431	D18F2x2[B4,B0,AC,A8]_dct[0]: DRAM User Data Pattern
395	D18F2x9C_x0D0F_E013_dct[0]: Phy PLL Regulator Wait Time	432	D18F2x2B8_dct[0]: DRAM Command 3
395	D18F2x9C_x0D0F_E019_dct[0]: Fence2	432	D18F2x2[C0,BC]_dct[0]: DRAM Command 4 & 5
396	D18F2x9C_x0D0F_E01A_dct[0]: M1 Fence Value	433	D18F2x2E0_dct[0]: Memory P-state Control and Status
397	D18F2xA4: DRAM Controller Temperature Throttle	433	D18F2x2E8_dct[0]_mp[1:0]: MRS Buffer
398	D18F2xA8_dct[0]: DRAM Controller Miscellaneous 2	434	D18F2x2EC_dct[0]_mp[1:0]: MRS Buffer
399	D18F2xAC: DRAM Controller Temperature Status	434	D18F2x2F0_dct[0]_mp[1:0]: DRAM Controller Misc 3
400	D18F2xF8: P-state Power Information 1	434	D18F2x400_dct[0]: GMC to DCT Control 0
400	D18F2xFC: P-state Power Information 2	435	D18F2x404_dct[0]: GMC to DCT Control 1
400	D18F2x104: P-state Power Information 3	435	D18F2x408_dct[0]: GMC to DCT Control 2
401	D18F2x110: DRAM Controller Select Low	436	D18F2x420_dct[0]: GMC to DCT FIFO Config 1
401	D18F2x114: DRAM Controller Select High	437	D18F3x00: Device/Vendor ID
402	D18F2x118: Memory Controller Configuration Low	437	D18F3x04: Status/Command
403	D18F2x11C: Memory Controller Configuration High	437	D18F3x08: Class Code/Revision ID
406	D18F2x1B0: Extended Memory Controller Configuration Low	437	D18F3x0C: Header Type
408	D18F2x1B4: Extended Memory Controller Configuration High Register	437	D18F3x34: Capability Pointer
409	D18F2x1BC_dct[0]: DRAM CKE to CS Map	437	D18F3x40: MCA NB Control
410	D18F2x200_dct[0]_mp[1:0]: DDR3 DRAM Timing 0	439	D18F3x44: MCA NB Configuration
411	D18F2x204_dct[0]_mp[1:0]: DDR3 DRAM Timing 1	442	D18F3x48: MCA NB Status Low
412	D18F2x208_dct[0]: DDR3 DRAM Timing 2	442	D18F3x4C: MCA NB Status High
412	D18F2x20C_dct[0]_mp[1:0]: DDR3 DRAM Timing 3	442	D18F3x50: MCA NB Address Low
413	D18F2x210_dct[0]_nbp[3:0]: DRAM NB P-state	442	D18F3x54: MCA NB Address High
414	D18F2x214_dct[0]_mp[1:0]: DDR3 DRAM Timing 4	442	D18F3x58: Scrub Rate Control
415	D18F2x218_dct[0]_mp[1:0]: DDR3 DRAM Timing 5	443	D18F3x5C: DRAM Scrub Address Low
416	D18F2x21C_dct[0]_mp[1:0]: DDR3 DRAM Timing 6	444	D18F3x60: DRAM Scrub Address High
416	D18F2x220_dct[0]: DDR3 DRAM Timing 7	444	D18F3x64: Hardware Thermal Control (HTC)
417	D18F2x224_dct[0]: DDR3 DRAM Timing 8	445	D18F3x68: Software P-state Limit
417	D18F2x228_dct[0]: DDR3 DRAM Timing 9	446	D18F3x6C: Data Buffer Count
418	D18F2x22C_dct[0]_mp[1:0]: DDR3 DRAM Timing 10	446	D18F3x70: SRI to XBAR Command Buffer Count
418	D18F2x[234:230]_dct[0]: DDR3 DRAM Read ODT Pattern [High:Low]	447	D18F3x74: XBAR to SRI Command Buffer Count
419	D18F2x[23C:238]_dct[0]: DDR3 DRAM Write ODT Pattern [High:Low]	449	D18F3x78: MCT to XBAR Buffer Count
419	D18F2x240_dct[0]_mp[1:0]: DDR3 DRAM ODT Control	450	D18F3x7C: Free List Buffer Count
420	D18F2x244_dct[0]: DRAM Controller Miscellaneous 3	450	D18F3x[84:80]: ACPI Power State Control
420	D18F2x248_dct[0]_mp[1:0]: DRAM Power Management 0	453	D18F3x88: NB Configuration 1 Low (NB_CFG1_LO)
422	D18F2x24C_dct[0]: DDR3 DRAM Power Management 1	453	D18F3x8C: NB Configuration 1 High (NB_CFG1_HI)
423	D18F2x250_dct[0]: DRAM Loopback and Training Control	453	D18F3xA0: Power Control Miscellaneous
424	D18F2x25[8,4]_dct[0]: DRAM Target [B, A] Base	454	D18F3xA4: Reported Temperature Control
425	D18F2x25C_dct[0]: DRAM Command 0	456	D18F3xA8: Pop Up and Down P-states
425	D18F2x260_dct[0]: DRAM Command 1	456	D18F3xB8: NB Array Address
		456	D18F3xBC: NB Array Data Port
		456	D18F3xBC_x8: DRAM ECC
		457	D18F3xD4: Clock Power/Timing Control 0
		459	D18F3xD8: Clock Power/Timing Control 1
		460	D18F3xDC: Clock Power/Timing Control 2
		461	D18F3xE4: Thermtrip Status
		462	D18F3xE8: Northbridge Capabilities
		463	D18F3xF0: DEV Capability Header Register
		463	D18F3xF4: DEV Function Register

463	D18F3xF8: DEV Data Port	495	D18F5x194: Name String Address Port
463	D18F3xF8_x4: DEV Secure Loader Control Register	495	D18F5x198: Name String Data Port
464	D18F3xFC: CPUID Family/Model/Stepping	495	D18F5x198_x[B:0]: Name String Data
464	D18F3x138: DCT0 Bad Symbol Identification	496	D18F5x240: ECC Exclusion Base Address Low
464	D18F3x13C: DCT1 Bad Symbol Identification	496	D18F5x244: ECC Exclusion Base Address High
464	D18F3x140: SRI to XCS Token Count	496	D18F5x248: ECC Exclusion Limit Address Low
465	D18F3x144: MCT to XCS Token Count	496	D18F5x24C: ECC Exclusion Limit Address High
466	D18F3x1[54:48]: Link to XCS Token Count	497	D18F5x260: Clock Power/Timing Control 8
467	D18F3x160: NB Machine Check Misc (DRAM Thresholding) 0 (MC4_MISC0)	498	IOMMUx00: Device Table Base Address Low
467	D18F3x168: NB Machine Check Misc (Link Thresholding) 1 (MC4_MISC1)	498	IOMMUx04: Device Table Base Address High
468	D18F3x17C: Extended Freelist Buffer Count	498	IOMMUx08: Command Buffer Base Address Low
468	D18F3x180: Extended NB MCA Configuration	498	IOMMUx0C: Command Buffer Base Address High
470	D18F3x188: NB Configuration 2	499	IOMMUx10: Event Log Base Address Low
470	D18F3x190: Downcore Control	499	IOMMUx14: Event Log Base Address High
471	D18F3x1A0: Core Interface Buffer Count	499	IOMMUx18: Control Low
472	D18F3x1CC: IBS Control	501	IOMMUx20: Exclusion Range Base Low
472	D18F3x1FC: Product Information Register 1	501	IOMMUx24: Exclusion Range Base High
472	D18F3x200: Performance Mode Control Register	502	IOMMUx28: Exclusion Range Limit Low
473	D18F3x238: DCT2 Bad Symbol Identification	502	IOMMUx2C: Exclusion Range Limit High
473	D18F3x23C: DCT3 Bad Symbol Identification	502	IOMMUx30: Extended Feature Low
473	D18F3x2B4: DCT and Fuse Power Gate Control	504	IOMMUx34: Extended Feature High
474	D18F4x00: Device/Vendor ID	504	IOMMUx38: PPR Log Base Address Low
474	D18F4x04: Status/Command	504	IOMMUx3C: PPR Log Base Address High
474	D18F4x08: Class Code/Revision ID	504	IOMMUx40: Hardware Error Upper Low
474	D18F4x0C: Header Type	504	IOMMUx44: Hardware Error Upper High
474	D18F4x34: Capabilities Pointer	505	IOMMUx48: Hardware Error Lower Low
475	D18F4x110: Sample and Residency Timers	505	IOMMUx4C: Hardware Error Lower High
475	D18F4x11[C:8]: C-state Control	505	IOMMUx50: Hardware Error Status
478	D18F4x124: C-state Interrupt Control	505	IOMMUx[78,70,68,60]: SMI Filter Low
478	D18F4x128: C-state Policy Control 1	506	IOMMUx[7C,74,6C,64]: SMI Filter High
479	D18F4x13C: SMU P-state Control	506	IOMMUxE0: Guest APIC Log Base Address Low
480	D18F4x15C: Core Performance Boost Control	506	IOMMUxE4: Guest APIC Log Base Address High
480	D18F4x164: Fixed Errata	506	IOMMUxE8: Guest APIC Log Tail Address Low
481	D18F4x16C: APM TDP Control	506	IOMMUxEC: Guest APIC Log Tail Address High
481	D18F4x1C0: Node Cac Register 1	507	IOMMUx1FF8: P2P Data
482	D18F4x250: TDP Limit 8	507	IOMMUx2000: Command Buffer Head Pointer
483	D18F5x00: Device/Vendor ID	507	IOMMUx2008: Command Buffer Tail Pointer
483	D18F5x04: Status/Command	507	IOMMUx2010: Event Log Head Pointer
483	D18F5x08: Class Code/Revision ID	508	IOMMUx2018: Event Log Tail Pointer
483	D18F5x0C: Header Type	508	IOMMUx2020: Status
483	D18F5x34: Capabilities Pointer	509	IOMMUx2030: PPR Log Head Pointer
483	D18F5x[70,60,50,40]: Northbridge Performance Event Select Low	510	IOMMUx2038: PPR Log Tail Pointer
484	D18F5x[74,64,54,44]: Northbridge Performance Event Select High	510	IOMMUx2040: Guest APIC Log Head Pointe Low
484	D18F5x[78,68,58,48]: Northbridge Performance Event Counter Low	510	IOMMUx2048: Guest APIC Log Tail Pointer Low
484	D18F5x[7C,6C,5C,4C]: Northbridge Performance Event Counter High	510	IOMMUx4000: Counter Configuration
484	D18F5x80: Compute Unit Status 1	511	IOMMUx4008: Counter PASID Bank Lock Low
485	D18F5x84: Northbridge Capabilities 2	511	IOMMUx400C: Counter PASID Bank Lock High
486	D18F5x88: NB Configuration 4 (NB_CFG4)	511	IOMMUx4010: Domain Bank Lock Low
486	D18F5x8C: NB Configuration 5 (NB_CFG5)	511	IOMMUx4014: Domain Bank Lock High
487	D18F5xE0: Processor TDP Running Average	511	IOMMUx4018: DeviceID Bank Lock Low
487	D18F5xE8: TDP Limit 3	512	IOMMUx401C: DeviceID Bank Lock High
487	D18F5xEC: Load Step Throttle Control	512	IOMMUx4[1,0][3:0]00: Counter Low
487	D18F5x128: Clock Power/Timing Control 3	512	IOMMUx4[1,0][3:0]04: Counter High
488	D18F5x12C: Clock Power/Timing Control 4	512	IOMMUx4[1,0][3:0]08: Counter Source
489	D18F5x16[C:0]: Northbridge P-state [3:0]	513	IOMMUx4[1,0][3:0]10: PASID Match Low
491	D18F5x170: Northbridge P-state Control	513	IOMMUx4[1,0][3:0]14: PASID Match High
492	D18F5x174: Northbridge P-state Status	514	IOMMUx4[1,0][3:0]18: Domain Match Low
493	D18F5x178: Northbridge Fusion Configuration	514	IOMMUx4[1,0][3:0]1C: Domain Match High
494	D18F5x17C: Miscellaneous Voltages	514	IOMMUx4[1,0][3:0]20: DeviceID Match Low
494	D18F5x188: Clock Power/Timing Control 5	515	IOMMUx4[1,0][3:0]24: DeviceID Match High
495	D18F5x18C: Clock Power/Timing Control 6	515	IOMMUx4[1,0][3:0]28: Counter Report Low
		516	IOMMUx4[1,0][3:0]2C: Counter Report High
		517	NBIOAPICx00: IO Register Select

517	NBIOAPICx10: IO Window	535	CPUID Fn0000_000C: Reserved
517	NBIOAPICx10_x00: IOAPIC ID	535	CPUID Fn0000_000D_EAX_x0: Processor Extended State Enumeration (ECX=0)
517	NBIOAPICx10_x01: IOAPIC Version	535	CPUID Fn0000_000D_EBX_x0: Processor Extended State Enumeration (ECX=0)
517	NBIOAPICx10_x02: IOAPIC Arbitration	536	CPUID Fn0000_000D_ECX_x0: Processor Extended State Enumeration (ECX=0)
518	NBIOAPICx10_x[4E:10:step2]: Redirection Table Entry [31:0]	536	CPUID Fn0000_000D_EDX_x0: Processor Extended State Enumeration (ECX=0)
518	NBIOAPICx20: IRQ Pin Assertion	536	CPUID Fn0000_000D_EAX_x1: Processor Extended State Enumeration (ECX=1)
518	NBIOAPICx40: EOI	536	CPUID Fn0000_000D_E[D,C,B]X_x1: Processor Extended State Enumeration (ECX=1)
519	APIC20: APIC ID	536	CPUID Fn0000_000D_EAX_x2: Processor Extended State Enumeration (ECX=2)
519	APIC30: APIC Version	536	CPUID Fn0000_000D_EBX_x2: Processor Extended State Enumeration (ECX=2)
519	APIC80: Task Priority (TPR)	537	CPUID Fn0000_000D_ECX_x2: Processor Extended State Enumeration (ECX=2)
519	APIC90: Arbitration Priority (APR)	537	CPUID Fn0000_000D_EDX_x2: Processor Extended State Enumeration (ECX=2)
520	APICA0: Processor Priority (PPR)	537	CPUID Fn8000_0000_EAX: Largest Extended Function Number
520	APICB0: End of Interrupt	537	CPUID Fn8000_0000_E[D,C,B]X: Processor Vendor
520	APICC0: Remote Read	537	CPUID Fn8000_0001_EAX: Family, Model, Stepping Identifiers
520	APICD0: Logical Destination (LDR)	538	CPUID Fn8000_0001_EBX: BrandId Identifier
520	APICE0: Destination Format	538	CPUID Fn8000_0001_ECX: Feature Identifiers
521	APICF0: Spurious-Interrupt Vector (SVR)	539	CPUID Fn8000_0001_EDX: Feature Identifiers
521	APIC[170:100]: In-Service (ISR)	540	CPUID Fn8000_000[4:2]_E[D,C,B,A]X: Processor Name String Identifier
521	APIC[1F0:180]: Trigger Mode (TMR)	541	CPUID Fn8000_0005_EAX: L1 TLB 2M/4M Identifiers
522	APIC[270:200]: Interrupt Request (IRR)	541	CPUID Fn8000_0005_EBX: L1 TLB 4K Identifiers
522	APIC280: Error Status	542	CPUID Fn8000_0005_ECX: L1 Data Cache Identifiers
523	APIC300: Interrupt Command Low (ICR Low)	542	CPUID Fn8000_0005_EDX: L1 Instruction Cache Identifiers
524	APIC310: Interrupt Command High (ICR High)	542	CPUID Fn8000_0006_EAX: L2 TLB 2M/4M Identifiers
524	APIC320: LVT Timer	543	CPUID Fn8000_0006_EBX: L2 TLB 4K Identifiers
525	APIC330: LVT Thermal Sensor	543	CPUID Fn8000_0006_ECX: L2 Cache Identifiers
525	APIC340: LVT Performance Monitor	544	CPUID Fn8000_0006_EDX: L3 Cache Identifiers
525	APIC3[60:50]: LVT LINT[1:0]	544	CPUID Fn8000_0007_EAX: Processor Feedback Capabilities
526	APIC370: LVT Error	544	CPUID Fn8000_0007_EBX: RAS Capabilities
526	APIC380: Timer Initial Count	545	CPUID Fn8000_0007_ECX: Advanced Power Management Information
526	APIC390: Timer Current Count	545	CPUID Fn8000_0007_EDX: Advanced Power Management Information
526	APIC3E0: Timer Divide Configuration	545	CPUID Fn8000_0008_EAX: Long Mode Address Size Identifiers
527	APIC400: Extended APIC Feature	546	CPUID Fn8000_0008_EBX: Reserved
527	APIC410: Extended APIC Control	546	CPUID Fn8000_0008_ECX: Size Identifiers
528	APIC420: Specific End Of Interrupt	546	CPUID Fn8000_0008_EDX: Reserved
528	APIC[4F0:480]: Interrupt Enable	546	CPUID Fn8000_0009: Reserved
528	APIC[530:500]: Extended Interrupt [3:0] Local Vector Table	547	CPUID Fn8000_000A_EAX: SVM Revision and Feature Identification
529	CPUID Fn0000_0000_EAX: Processor Vendor and Largest Standard Function Number	547	CPUID Fn8000_000A_EBX: SVM Revision and Feature Identification
529	CPUID Fn0000_0000_E[D,C,B]X: Processor Vendor	547	CPUID Fn8000_000A_ECX: SVM Revision and Feature Identification
529	CPUID Fn0000_0001_EAX: Family, Model, Stepping Identifiers	547	CPUID Fn8000_000A_EDX: SVM Revision and Feature Identification
530	CPUID Fn0000_0001_EBX: LocalApicId, LogicalProcessorCount, CLFlush	548	CPUID Fn8000_00[18:0B]: Reserved
530	CPUID Fn0000_0001_ECX: Feature Identifiers	548	CPUID Fn8000_0019_EAX: L1 TLB 1G Identifiers
531	CPUID Fn0000_0001_EDX: Feature Identifiers	548	CPUID Fn8000_0019_EBX: L2 TLB 1G Identifiers
532	CPUID Fn0000_000[4:2]: Reserved	549	CPUID Fn8000_0019_E[D,C]X: Reserved
532	CPUID Fn0000_0005_EAX: Monitor/MWait	549	CPUID Fn8000_001A_EAX: Performance Optimization Identifiers
533	CPUID Fn0000_0005_EBX: Monitor/MWait	549	CPUID Fn8000_001A_E[D,C,B]X: Reserved
533	CPUID Fn0000_0005_ECX: Monitor/MWait	549	CPUID Fn8000_001B_EAX: Instruction Based Sampling Identifiers
533	CPUID Fn0000_0005_EDX: Monitor/MWait	550	CPUID Fn8000_001B_E[D,C,B]X: Instruction Based Sampling Identifiers
533	CPUID Fn0000_0006_EAX: Thermal and Power Management	550	CPUID Fn8000_001C_EAX: Lightweight Profiling Capabilities 0
533	CPUID Fn0000_0006_EBX: Thermal and Power Management	550	CPUID Fn8000_001C_EBX: Lightweight Profiling Capabilities 0
533	CPUID Fn0000_0006_ECX: Thermal and Power Management	550	CPUID Fn8000_001C_ECX: Lightweight Profiling Capabilities 0
534	CPUID Fn0000_0006_EDX: Thermal and Power Management	550	CPUID Fn8000_001C_EDX: Lightweight Profiling Capabilities 0
534	CPUID Fn0000_0007_EAX_x0: Structured Extended Feature Identifiers (ECX=0)		
534	CPUID Fn0000_0007_EBX_x0: Structured Extended Feature Identifiers (ECX=0)		
534	CPUID Fn0000_0007_ECX_x0: Structured Extended Feature Identifiers (ECX=0)		
535	CPUID Fn0000_0007_EDX_x0: Structured Extended Feature Identifiers (ECX=0)		
535	CPUID Fn0000_000[A:8]: Reserved		
535	CPUID Fn0000_000B: Reserved		

551	CPUID Fn8000_001D_EAX_x0: Cache Properties	585	MSR0000_0413: NB Machine Check Misc 4 (DRAM Thresholding) 0 (MC4_MISC0)
551	CPUID Fn8000_001D_EAX_x1: Cache Properties	586	MSR0000_0414: MC5 Machine Check Control (MC5_CTL)
552	CPUID Fn8000_001D_EAX_x2: Cache Properties	586	MSR0000_0415: MC5 Machine Check Status (MC5_STATUS)
552	CPUID Fn8000_001D_EAX_x3: Cache Properties	587	MSR0000_0416: MC5 Machine Check Address (MC5_ADDR)
553	CPUID Fn8000_001D_EBX_x0: Cache Properties	588	MSR0000_0417: MC5 Machine Check Miscellaneous (MC5_MISC)
553	CPUID Fn8000_001D_EBX_x1: Cache Properties	589	MSRC000_0080: Extended Feature Enable (EFER)
553	CPUID Fn8000_001D_EBX_x2: Cache Properties	589	MSRC000_0081: SYSCALL Target Address (STAR)
553	CPUID Fn8000_001D_EBX_x3: Cache Properties	589	MSRC000_0082: Long Mode SYSCALL Target Address (STAR64)
554	CPUID Fn8000_001D_ECX_x0: Cache Properties	590	MSRC000_0083: Compatibility Mode SYSCALL Target Address (STARCOMPAT)
554	CPUID Fn8000_001D_ECX_x1: Cache Properties	590	MSRC000_0084: SYSCALL Flag Mask (SYSCALL_FLAG_MASK)
554	CPUID Fn8000_001D_ECX_x2: Cache Properties	590	MSRC000_0100: FS Base (FS_BASE)
554	CPUID Fn8000_001D_ECX_x3: Cache Properties	590	MSRC000_0101: GS Base (GS_BASE)
555	CPUID Fn8000_001D_EDX_x0: Cache Properties	590	MSRC000_0102: Kernel GS Base (KernelGSbase)
555	CPUID Fn8000_001D_EDX_x1: Cache Properties	590	MSRC000_0103: Auxiliary Time Stamp Counter (TSC_AUX)
555	CPUID Fn8000_001D_EDX_x2: Cache Properties	591	MSRC000_0104: Time Stamp Counter Ratio (TscRateMsr)
555	CPUID Fn8000_001D_EDX_x3: Cache Properties	591	MSRC000_0408: NB Machine Check Misc 4 (Link Thresholding) 1 (MC4_MISC1)
556	CPUID Fn8000_001E_EAX: Extended APIC ID	593	MSRC000_0409: Reserved
556	CPUID Fn8000_001E_EBX: Compute Unit Identifiers	594	MSRC000_040[F:A]: Reserved
556	CPUID Fn8000_001E_EDX: Reserved	595	MSRC001_00[03:00]: Performance Event Select (PERF_CTL[3:0])
557	MSR0000_0000: Load-Store MCA Address	596	MSRC001_00[07:04]: Performance Event Counter (PERF_CTR[3:0])
557	MSR0000_0001: Load-Store MCA Status	597	MSRC001_0010: System Configuration (SYS_CFG)
557	MSR0000_0010: Time Stamp Counter (TSC)	597	MSRC001_0015: Hardware Configuration (HWCR)
557	MSR0000_001B: APIC Base Address (APIC_BAR)	600	MSRC001_00[18,16]: IO Range Base (IORR_BASE[1:0])
558	MSR0000_002A: Cluster ID (EBL_CR_POWERON)	600	MSRC001_00[19,17]: IO Range Mask (IORR_MASK[1:0])
558	MSR0000_00E7: Max Performance Frequency Clock Count (MPERF)	600	MSRC001_001A: Top Of Memory (TOP_MEM)
558	MSR0000_00E8: Actual Performance Frequency Clock Count (APERF)	601	MSRC001_001D: Top Of Memory 2 (TOM2)
558	MSR0000_00FE: MTRR Capabilities (MTRRcap)	601	MSRC001_001F: Northbridge Configuration 1 (NB_CFG1)
558	MSR0000_0174: SYSENTER CS (SYSENTER_CS)	602	MSRC001_0022: Machine Check Exception Redirection
559	MSR0000_0175: SYSENTER ESP (SYSENTER_ESP)	602	MSRC001_00[35:30]: Processor Name String
559	MSR0000_0176: SYSENTER EIP (SYSENTER_EIP)	603	MSRC001_003E: Hardware Thermal Control (HTC)
559	MSR0000_0179: Global Machine Check Capabilities (MCG_CAP)	604	MSRC001_0044: DC Machine Check Control Mask (MC0_CTL_MASK)
559	MSR0000_017A: Global Machine Check Status (MCG_STAT)	604	MSRC001_0045: IC Machine Check Control Mask (MC1_CTL_MASK)
560	MSR0000_017B: Global Machine Check Exception Reporting Control (MCG_CTL)	605	MSRC001_0046: BU Machine Check Control Mask (MC2_CTL_MASK)
560	MSR0000_01D9: Debug Control (DBG_CTL_MSR)	605	MSRC001_0047: Reserved (MC3_CTL_MASK)
560	MSR0000_01DB: Last Branch From IP (BR_FROM)	605	MSRC001_0048: NB Machine Check Control Mask (MC4_CTL_MASK)
560	MSR0000_01DC: Last Branch To IP (BR_TO)	606	MSRC001_0049: FR Machine Check Control Mask (MC5_CTL_MASK)
561	MSR0000_01DD: Last Exception From IP	606	MSRC001_00[53:50]: IO Trap (SMI_ON_IO_TRAP_[3:0])
561	MSR0000_01DE: Last Exception To IP	607	MSRC001_0054: IO Trap Control (SMI_ON_IO_TRAP_CTL_STS)
561	MSR0000_020[F:0]: Variable-Size MTRRs Base/Mask	608	MSRC001_0055: Interrupt Pending
562	MSR0000_02[6F:68,59:58,50]: Fixed-Size MTRRs	608	MSRC001_0056: SMI Trigger IO Cycle
564	MSR0000_0277: Page Attribute Table (PAT)	608	MSRC001_0058: MMIO Configuration Base Address
565	MSR0000_02FF: MTRR Default Memory Type (MTRRdefType)	609	MSRC001_0060: BIST Results
565	MSR0000_0400: MC0 Machine Check Control (MC0_CTL)	609	MSRC001_0061: P-state Current Limit
566	MSR0000_0401: MC0 Machine Check Status (MC0_STATUS)	610	MSRC001_0062: P-state Control
569	MSR0000_0402: MC0 Machine Check Address (MC0_ADDR)	610	MSRC001_0063: P-state Status
569	MSR0000_0403: MC0 Machine Check Miscellaneous (MC0_MISC)	610	MSRC001_00[6B:64]: P-state [7:0]
570	MSR0000_0404: MC1 Machine Check Control (MC1_CTL)	612	MSRC001_0070: COFVID Control
570	MSR0000_0405: MC1 Machine Check Status (MC1_STATUS)	613	MSRC001_0071: COFVID Status
572	MSR0000_0406: MC1 Machine Check Address (MC1_ADDR)	614	MSRC001_0073: C-state Base Address
572	MSR0000_0407: MC1 Machine Check Miscellaneous (MC1_MISC)	614	MSRC001_0074: CPU Watchdog Timer (CpuWdtCfg)
572	MSR0000_0408: MC2 Machine Check Control (MC2_CTL)	615	MSRC001_007A: Compute Unit Power Accumulator
573	MSR0000_0409: MC2 Machine Check Status (MC2_STATUS)	615	MSRC001_007B: Max Compute Unit Power Accumulator
576	MSR0000_040A: MC2 Machine Check Address (MC2_ADDR)	615	MSRC001_0111: SMM Base Address (SMM_BASE)
576	MSR0000_040B: MC2 Machine Check Miscellaneous (MC2_MISC)	616	MSRC001_0112: SMM TSeg Base Address (SMMAddr)
576	MSR0000_040C: MC3 Machine Check Control (MC3_CTL)	616	MSRC001_0113: SMM TSeg Mask (SMMMask)
576	MSR0000_040D: MC3 Machine Check Status (MC3_STATUS)		
576	MSR0000_040E: MC3 Machine Check Address (MC3_ADDR)		
577	MSR0000_040F: MC3 Machine Check Miscellaneous (MC3_MISC)		
577	MSR0000_0410: MC4 Machine Check Control (MC4_CTL)		
578	MSR0000_0411: MC4 Machine Check Status (MC4_STATUS)		
582	MSR0000_0412: MC4 Machine Check Address (MC4_ADDR)		

617	MSRC001_0114: Virtual Machine Control (VM_CR)	643	PMCx044: Data Cache Lines Evicted
618	MSRC001_0115: IGNNE	643	PMCx045: L1 DTLB Miss and L2 DTLB Hit
618	MSRC001_0116: SMM Control (SMM_CTL)	643	PMCx046: DTLB Miss
619	MSRC001_0117: Virtual Machine Host Save Physical Address (VM_HSAVE_PA)	643	PMCx047: Misaligned Accesses
619	MSRC001_0118: SVM Lock Key	643	PMCx04B: Prefetch Instructions Dispatched
619	MSRC001_011A: Local SMI Status	644	PMCx04C: DCACHE Misses by Locked Instructions
619	MSRC001_0140: OS Visible Work-around MSR0 (OSVW_ID_Length)	644	PMCx04D: L1 DTLB Hit
620	MSRC001_0141: OS Visible Work-around MSR1 (OSVW_Status)	644	PMCx052: Ineffective Software Prefetches
620	MSRC001_023[6,4,2,0]: L2I Performance Event Select (L2I_PERF_CTL[3:0])	644	PMCx054: Global Page Invalidations
621	MSRC001_023[7,5,3,1]: L2I Performance Event Counter (L2I_PERF_CTR[3:0])	644	PMCx062: Command Related to Read Block Operations
622	MSRC001_024[6,4,2,0]: Northbridge Performance Event Select (NB_PERF_CTL[3:0])	645	PMCx063: Command Related to Change to Dirty Operations
622	MSRC001_024[7,5,3,1]: Northbridge Performance Event Counter (NB_PERF_CTR[3:0])	645	PMCx065: Memory Requests by Type
623	MSRC001_0280: Performance Time Stamp Counter (CU_PTSC)	645	PMCx067: Data Cache Prefetches
624	MSRC001_1002: CPUID Features for CPUID Fn0000_0007_E[B,A]X_x0	646	PMCx068: MAB Requests
624	MSRC001_1004: CPUID Features (Features)	646	PMCx069: MAB Wait Cycles
626	MSRC001_1005: Extended CPUID Features (ExtFeatures)	646	PMCx06C: System Response by Coherence State
627	MSRC001_101[B:9]: Address Mask For DR[3:1] Breakpoints	647	PMCx06D: Data Written to System
628	MSRC001_1020: Load-Store Configuration (LS_CFG)	647	PMCx075: Cache Cross-invalidates
629	MSRC001_1021: Instruction Cache Configuration (IC_CFG)	647	PMCx076: CPU Clocks not Halted
629	MSRC001_1022: Data Cache Configuration (DC_CFG)	648	PMCx162: PDC Miss
629	MSRC001_1023: Bus Unit Configuration (BU_CFG)	648	PMCx080: Instruction Cache Fetches
629	MSRC001_1027: Address Mask For DR0 Breakpoints (DR0_ADDR_MASK)	648	PMCx081: Instruction Cache Misses
630	MSRC001_1028: Floating Point Configuration (FP_CFG)	648	PMCx082: Instruction Cache Refills from L2
630	MSRC001_102A: Bus Unit Configuration 2 (BU_CFG2)	648	PMCx083: Instruction Cache Refills from System
630	MSRC001_1030: IBS Fetch Control (IbsFetchCtl)	649	PMCx084: L1 ITLB Miss, L2 ITLB Hit
631	MSRC001_1031: IBS Fetch Linear Address (IbsFetchLinAd)	649	PMCx085: ITLB Miss
631	MSRC001_1032: IBS Fetch Physical Address (IbsFetchPhysAd)	649	PMCx087: Instruction Fetch Stall
632	MSRC001_1033: IBS Execution Control (IbsOpCtl)	649	PMCx088: Return Stack Hits
633	MSRC001_1034: IBS Op Logical Address (IbsOpRip)	649	PMCx089: Return Stack Overflows
633	MSRC001_1035: IBS Op Data (IbsOpData)	649	PMCx08B: Instruction Cache Victims
634	MSRC001_1036: IBS Op Data 2 (IbsOpData2)	649	PMCx08C: Instruction Cache Lines Invalidated
634	MSRC001_1037: IBS Op Data 3 (IbsOpData3)	650	PMCx099: ITLB Reloads
636	MSRC001_1038: IBS DC Linear Address (IbsDcLinAd)	650	PMCx09A: ITLB Reloads Aborted
636	MSRC001_1039: IBS DC Physical Address (IbsDcPhysAd)	650	PMCx19A: Retired Indirect Branch Info
636	MSRC001_103A: IBS Control	650	PMCx0C0: Retired Instructions
637	MSRC001_103B: IBS Branch Target Address (BP_IBSTGT_RIP)	650	PMCx0C1: Retired uops
637	MSRC001_1090: Processor Feedback Constants 0	650	PMCx0C2: Retired Branch Instructions
637	MSRC001_10A0: L2I Configuration (L2I_CFG)	650	PMCx0C3: Retired Mispredicted Branch Instructions
639	PMCx000: Dispatched FPU Operations	650	PMCx0C4: Retired Taken Branch Instructions
639	PMCx001: FP Scheduler Empty	651	PMCx0C5: Retired Taken Branch Instructions Mispredicted
639	PMCx002: Dispatched Fast Flag FPU Operations	651	PMCx0C6: Retired Far Control Transfers
639	PMCx003: Retired SSE/AVX Operations	651	PMCx0C7: Retired Branch Resyncs
640	PMCx005: Retired Serializing Ops	651	PMCx0C8: Retired Near Returns
640	PMCx011: Retired x87 Floating Point Operations	651	PMCx0C9: Retired Near Returns Mispredicted
640	PMCx020: Segment Register Loads	651	PMCx0CA: Retired Mispredicted Taken Branch Instructions due to Target Mismatch
640	PMCx021: Pipeline Restart Due to Self-Modifying Code	651	PMCx0CB: Retired MMX/FP Instructions
641	PMCx022: Pipeline Restart Due to Probe Hit	651	PMCx0CD: Interrupts-Masked Cycles
641	PMCx024: Locked Operations	651	PMCx0CE: Interrupts-Masked Cycles with Interrupt Pending
641	PMCx026: Retired CLFLUSH Instructions	652	PMCx0CF: Interrupts Taken
641	PMCx027: Retired CPUID Instructions	652	PMCx0DB: FPU Exceptions
641	PMCx029: LS Dispatch	652	PMCx0D[F:C]: DR[3:0] Breakpoint Matches
641	PMCx02A: Canceled Store to Load Forward Operations	652	PMCx1CF: Tagged IBS Ops
642	PMCx040: Data Cache Accesses	652	PMCx1D0: Tagged IBS Ops Retired
642	PMCx041: Data Cache Misses	653	L2IPMCx060: Command Related to Victim Buffers
642	PMCx042: Data Cache Refills from L2 or Northbridge	653	L2IPMCx061: Command Related to Masked Operations
642	PMCx043: Data Cache Refills from the northbridge	653	L2IPMCx062: Command Related to Read Block Operations
		653	L2IPMCx063: Command Related to Change to Dirty Operations
		654	L2IPMCx06C: Response From System on Cache Refills
		654	L2IPMCx07D: Requests to L2 Cache
		654	L2IPMCx07E: L2 Cache Misses
		655	L2IPMCx07F: L2 Fill/Writeback
		655	NBPMCx0E4: Memory Controller Bypass Counter Saturation

655	NBPMCx0E8: Thermal Status	673	IO073_x53: RTC Extended RAM Data Port
656	NBPMCx0E9: CPU/IO Requests to Memory/IO	673	IO073_x7E: RTC Time Clear
656	NBPMCx0EA: Cache Block Commands	673	IO073_x7F: RTC RAM Enable
657	NBPMCx0EB: Sized Commands	673	IO080: PostCode 0
657	NBPMCx0EC: Probe Responses and Upstream Requests	673	IO081: PostCode 1
658	NBPMCx1E0: CPU to DRAM Requests to Target Node	674	IO081: Dma_PageCh2
658	NBPMCx1E1: IO to DRAM Requests to Target Node	674	IO082: PostCode 2
659	NBPMCx1E2: CPU Read Command Latency to Target Node 0-3	674	IO082: Dma_PageCh3
659	NBPMCx1E3: CPU Read Command Requests to Target Node 0-3	674	IO083: PostCode 3
659	NBPMCx1E4: CPU Read Command Latency to Target Node 4-7	674	IO083: Dma_PageCh1
660	NBPMCx1E5: CPU Read Command Requests to Target Node 4-7	674	IO084: Dma_Page_Reserved1
660	NBPMCx1E6: CPU Command Latency to Target Node 0-3/4-7	674	IO085: Dma_Page_Reserved2
661	NBPMCx1E7: CPU Requests to Target Node 0-3/4-7	675	IO086: Dma_Page_Reserved3
661	NBPMCx1EB: Request Cache Status 1	675	IO087: Dma_PageCh0
661	NBPMCx1F0: Memory Controller Requests	675	IO088: Dma_Page_Reserved4
662	NBPMCx3EC: DRAM Accesses	675	IO089: Dma_PageCh6
662	NBPMCx3ED: DRAM Controller Page Table Overflows	675	IO08A: Dma_PageCh7
663	NBPMCx3EE: Memory Controller DRAM Command Slots Missed	675	IO08B: Dma_PageCh5
663	NBPMCx3EF: Memory Controller Turnarounds	675	IO08C: Dma_Page_Reserved5
664	IO000: Dma_Ch 0	675	IO08D: Dma_Page_Reserved6
664	IO002: Dma_Ch 1	676	IO08E: Dma_Page_Reserved7
664	IO004: Dma_Ch 2	676	IO08F: Dma_Refresh
664	IO006: Dma_Ch 3	676	IO092: FastInit
664	IO008: Dma_Status	676	IO0A0: IntrCntrl2Reg1
664	IO009: Dma_WriteRequest	676	IO0A1: IntrCntrl2Reg2
664	IO00A: Dma_WriteMask	676	IO0C0: Dma2_Ch4Addr
665	IO00B: Dma_WriteMode	676	IO0C2: Dma2_Ch4Cnt
665	IO00C: Dma_Clear	677	IO0C4: Dma2_Ch5Addr
665	IO00D: Dma_MasterClr	677	IO0C6: Dma2_Ch5Cnt
665	IO00E: Dma_ClrMask	677	IO0C8: Dma2_Ch6Addr
665	IO00F: Dma_AllMask	677	IO0CA: Dma2_Ch6Cnt
665	IO020: IntrCntrl1Reg1	677	IO0CC: Dma2_Ch7Addr
665	IO021: IntrCntrl1Reg2	677	IO0CE: Dma_Ch7Cnt
666	IO022: IMCR_Index	677	IO0D0: Dma_Status
666	IO023: IMCR_Data	677	IO0D2: Dma_WriteRequest
666	IO040: TimerCh0	678	IO0D4: Dma_WriteMask
666	IO041: TimerCh1	678	IO0D6: Dma_WriteMode
666	IO042: TimerCh2	678	IO0D8: Dma_Clear
666	IO043: Tmr1CntrlWord	678	IO0DA: Dma_MasterClr
667	IO060: Keyboard Data	678	IO0DC: Dma_ClrMask
667	IO061: Nmi Status	678	IO0DE: Dma_AllMask
667	IO064: Keyboard Command Status	678	IO0F0: NCP Error
668	IO070: RtcAddrPort and NmiMask	679	IO4D0: IntrEdgeControl
668	IO071: RtcDataPort	679	IOC00: Pci_Intr_Index
668	IO072: Alternate RTC AddrPort	680	IOC01: Pci_Intr_Data
668	IO073: Alternate RTC DataPort	680	IOC01_x0[7:0]: PCI INT[H#,G#,F#,E#,D#,C#,B#,A#] Map
668	IO073_x00: RTC Seconds	681	IOC01_x08: Intr Misc Map
669	IO073_x01: RTC Seconds Alarm	681	IOC01_x09: Intr Misc 0 Map
669	IO073_x02: RTC Minutes	682	IOC01_x0A: IntrMisc1Map
669	IO073_x03: RTC Minutes Alarm	682	IOC01_x0B: IntrMisc2Map
669	IO073_x04: RTC Hours	682	IOC01_x0[7F:C]: PCI Interrupt Map
669	IO073_x05: RTC Hours Alarm	682	IOC14: Pci_Error
670	IO073_x06: RTC Day of Week	682	IOCD0: PM2_Index
670	IO073_x07: RTC Date of Month	683	IOCD1: PM2_Data
670	IO073_x08: RTC Month	683	IOCD4: BIO SRAMIndex
670	IO073_x09: RTC Year	683	IOCD5: BIO SRAM Data
670	IO073_x0A: RTC Register A	683	IOCD6: PM_Index
671	IO073_x0B: RTC Register B	683	IOCD7: PM_Data
672	IO073_x0C: RTC Register C	683	IOCF9: System Reset Register
672	IO073_x0D: RTC Date Alarm	685	ABx00: AB Index Register
672	IO073_x32: RTC AltCentury	685	ABx04: AB Data Register
672	IO073_x48: RTC Century	685	ABx04_x54: Misc Control 1
673	IO073_x50: RTC Extended RAM Address Port	686	ABx04_x58: B-Link RAB Control

686	ABx04_x80: B-Link DMA Prefetch Control	701	D11F0x88: PHY Global Control 1
686	ABx04_x90: BIF Control 0	701	D11F0x8C: PHY Global Control 2
686	ABx04_x94: MSI Control	701	D11F0x98: PHY Fine Tune PortX GenX Setting
687	ABx04_x204: SBG Upstream Control	701	D11F0x9C: PortX Setting 2
687	ABx04_x10054: A-Link Arbitration Control and Clock Control	702	D11F0xB4: PortX BIST Control/Status
687	ABx04_x10090: Misc Control 3	703	D11F0xB7: PortX BIST Port Select
688	D11F0x00: Device/Vendor ID	703	D11F0xBC: T-Mode BIST Transit Pattern DW1
688	D11F0x04: Status/Command	703	D11F0xC0: T-Mode BIST Transit Pattern DW2
689	D11F0x08: Revision ID/Class Code	703	D11F0xC4: T-Mode BIST Transit Control
690	D11F0x0C: Header Type Register	703	D11F0xD0: Advanced Features Capability Register 0
690	D11F0x10: Primary IDE CS0 Base Address(BAR0)	704	D11F0xD4: Advanced Features Capability Register 1
691	D11F0x14: Primary IDE CS1 Base Address(BAR1)	704	D11F0xE0: PCI Target Control TimeOut Counter
691	D11F0x18: Secondary IDE CS0 Base Address (BAR2)	705	IDE[1:0]x00: IDE DATA
691	D11F0x1C: Secondary IDE CS1 Base Address (BAR3)	705	IDE[1:0]x01: Feature and Error
691	D11F0x20: Bus Master Interface Register Base Address (BAR4)	705	IDE[1:0]x02: Sector Count
692	D11F0x24: AHCI Base Address (BAR5)	705	IDE[1:0]x03: Sector Number
692	D11F0x2C: Subsystem ID and Subsystem Vendor ID	705	IDE[1:0]x04: Cylinder Low
692	D11F0x34: Capabilities Pointer	706	IDE[1:0]x05: Cylinder High
692	D11F0x3C: Interrupt Line	706	IDE[1:0]x06: Drive and Head
692	D11F0x40: Misc Control	706	IDE[1:0]x07: Command and Status
693	D11F0x44: Watch Dog Control And Status	706	IDEA[1:0]x02: Device Control and Alternate Status
693	D11F0x50: MSI Control	706	IDE_BMx0[8,0]: Bus Master IDE Command
694	D11F0x54: MSI Address	707	IDE_BMx0[A,2]: Bus-master IDE Status
694	D11F0x58: MSI Upper Address	707	IDE_BMx0[C,4]: Descriptor Table Pointer
694	D11F0x5C: MSI Data	708	SATAx00: HBA Capabilities (CAP)
694	D11F0x60: Power Management Capability	709	SATAx04: Global HBA Control (GHC)
695	D11F0x64: PCI Power Management Control And Status	710	SATAx08: Interrupt Status (IS)
695	D11F0x70: Serial ATA Capability Register 0	711	SATAx0C: Ports Implemented (PI)
696	D11F0x74: Serial ATA Capability Register 1	711	SATAx10: AHCI Version (VS)
696	D11F0x78: IDP Index Register	711	SATAx14: Command Completion Coalescing Control (CCC_CTL)
696	D11F0x7C: IDP Data Register	712	SATAx18: Command Completion Coalescing Ports (CCC_PORTS)
696	D11F0x7C_x00: HBA Capabilities (CAP)	712	SATAx1C: Enclosure Management Location (EM_LOC)
696	D11F0x7C_x04: Global HBA Control (GHC)	712	SATAx20: Enclosure Management Control (EM_CTL)
697	D11F0x7C_x08: Interrupt Status (IS)	713	SATAx24: HBA Capabilities Extended (CAP2)
697	D11F0x7C_x0C: Ports Implemented (PI)	713	SATAx28: BIOS/OS Handoff Control and Status (BOHC)
697	D11F0x7C_x10: AHCI Version (VS)	714	SATAx1[8,0]0: Port 1,0 Command List Base Address (PxCLB)
697	D11F0x7C_x14: Command Completion Coalescing Control (CCC_CTL)	714	SATAx1[8,0]4: Port 1,0 Command List Base Upper Address (PxCLBU)
697	D11F0x7C_x18: Command Completion Coalescing Ports (CCC_PORTS)	714	SATAx1[8,0]8: Port 1,0 FIS Base Address (PxFB)
697	D11F0x7C_x1C: Enclosure Management Location (EM_LOC)	714	SATAx1[8,0]C: Port 1,0 FIS Base Address Upper (PxFBU)
697	D11F0x7C_x20: Enclosure Management Control (EM_CTL)	715	SATAx1[9,1]0: Port 1,0 Interrupt Status (PxIS)
697	D11F0x7C_x24: HBA Capabilities Extended (CAP2)	716	SATAx1[9,1]4: Port 1,0 Interrupt Enable (PxIE)
698	D11F0x7C_x28: BIOS/OS Handoff Control and Status (BOHC)	717	SATAx1[9,1]8: Port 1,0 Command and Status (PxCMD)
698	D11F0x7C_x1[8,0]0: Port 1,0 Command List Base Address (PxCLB)	719	SATAx1[A,2]0: Port 1,0 Task File Data (PxTFD)
698	D11F0x7C_x1[8,0]4: Port 1,0 Command List Base Upper Address (PxCLBU)	720	SATAx1[A,2]4: Port 1,0 Signature (PxSIG)
698	D11F0x7C_x1[8,0]8: Port 1,0 FIS Base Address (PxFB)	720	SATAx1[A,2]8: Port 1,0 Serial ATA Status (PxSSTS)
698	D11F0x7C_x1[8,0]C: Port 1,0 FIS Base Address Upper (PxFBU)	721	SATAx1[A,2]C: Port 1,0 Serial ATA Control (PxSCTL)
698	D11F0x7C_x1[9,1]0: Port 1,0 Interrupt Status (PxIS)	722	SATAx1[B,3]0: Port 1,0 Serial ATA Error(PxSERR)
698	D11F0x7C_x1[9,1]4: Port 1,0 Interrupt Enable (PxIE)	724	SATAx1[B,3]4: Port 1,0 Serial ATA Active (PxSACT)
698	D11F0x7C_x1[9,1]8: Port 1,0 Command and Status (PxCMD)	725	SATAx1[B,3]8: Port 1,0 Command Issue (PxCI)
699	D11F0x7C_x1[A,2]0: Port 1,0 Task File Data (PxTFD)	725	SATAx1[B,3]C: Port 1,0 SNotification (PxSNTF)
699	D11F0x7C_x1[A,2]4: Port 1,0 Signature (PxSIG)	725	SATAx1[C,4]0: Port 1,0 FIS-based Switching Control (PxFBS)
699	D11F0x7C_x1[A,2]8: Port 1,0 Serial ATA Status (PxSSTS)	726	SATAx1[C,4]4: Port 1,0 Device Sleep (PxDEVSLP)
699	D11F0x7C_x1[A,2]C: Port 1,0 Serial ATA Control (PxSCTL)	727	SATA_EMx00: Message Header
699	D11F0x7C_x1[B,3]0: Port 1,0 Serial ATA Error (PxSERR)	728	SATA_EMx04: Write SGPIO Register Request (I)
699	D11F0x7C_x1[B,3]4: Port 1,0 Serial ATA Active (PxSACT)	728	SATA_EMx08: Write SGPIO Register Request (II)
699	D11F0x7C_x1[B,3]8: Port 1,0 Command Issue (PxCI)	729	SATA_EMx0C: Write SGPIO Register Request (III)
699	D11F0x7C_x1[B,3]C: Port 1,0 SNotification (PxSNTF)	730	D[16,13,12]F0x00: Device/Vendor ID
700	D11F0x7C_x1[C,4]0: Port 1,0 FIS-based Switching Control (PxFBS)	730	D[16,13,12]F0x04: Status/Command
700	D11F0x80: PHY Core Control 1	731	D[16,13,12]F0x08: Revision ID / Class Code
700	D11F0x84: PHY Core Control 2	731	D[16,13,12]F0x0C: Miscellaneous
		732	D[16,13,12]F0x10: BAR_EHCI
		732	D[16,13,12]F0x2C: Subsystem ID / Subsystem Vendor ID
		732	D[16,13,12]F0x34: Capability Pointer

732	D[16,13,12]F0x3C: Interrupt Line	763	D10F0x4C_x1C: USB DCLK Event Counter Control
732	D[16,13,12]F0x50: EHCI Misc Control	763	D10F0x4C_x4000_0000: UTMI Control
734	D[16,13,12]F0x54: EHCI Spare 1	763	D10F0x4C_x4000_0004: USB PHY Status
735	D[16,13,12]F0x60: Serial Bus Release Number / FLADJ	764	D10F0x4C_x4000_0008: USB Common PHY Calibration and Control
735	D[16,13,12]F0x64: Misc Control 2	764	D10F0x4C_x4000_000C: USB Common PHY Control
736	D[16,13,12]F0x70: Over-Current Control 1	765	D10F0x4C_x4000_0010: HS Loopback Test
736	D[16,13,12]F0x74: Misc Control 2	765	D10F0x4C_x4000_0014: CL Loopback Control
736	D[16,13,12]F0x78: Target Timeout Control	766	D10F0x4C_x4000_0018: Misc Control
737	D[16,13,12]F0x80: Hub Config 0	766	D10F0x4C_x4000_0020: USB SCLK Event Counter 0
737	D[16,13,12]F0x84: Hub Config 1	766	D10F0x4C_x4000_0024: USB SCLK Event Counter 1
738	D[16,13,12]F0x88: HUB Config 2	766	D10F0x4C_x4000_0028: USB SCLK Event Counter Select
738	D[16,13,12]F0x8C: HUB Config 3	767	D10F0x4C_x4000_002C: USB SCLK Event Counter Control
739	D[16,13,12]F0x9C: HUB Status	767	D10F0x4C_x4000_0048: LPM Control
739	D[16,13,12]F0xA0: USB Legacy Support Extended Capability	768	D10F0x4C_x4000_0050: USB Common PHY Control 2
740	D[16,13,12]F0xA4: USB Legacy Support Control / Status	768	D10F0x4C_x4000_0054: USB Common PHY Control 3
741	D[16,13,12]F0xC0: PME Capability	768	D10F0x50: PME Capability
741	D[16,13,12]F0xC4: PME Control / Status	769	D10F0x54: PME Control / Status
742	D[16,13,12]F0xD0: MSI Control	770	D10F0x60: SBRN
742	D[16,13,12]F0xD4: MSI Address	770	D10F0x70: MSI Control
742	D[16,13,12]F0xD8: MSI Upper Address	771	D10F0x74: MSI Address
742	D[16,13,12]F0xDC: MSI Data	771	D10F0x78: MSI Upper Address
743	D[16,13,12]F0xF0: Function Level Reset Capability	771	D10F0x7C: MSI Data
743	D[16,13,12]F0xF4: Function Level Reset Control	771	D10F0x80: MSI Mask Bits
744	EHCI[3:1]x00: Capability Length	771	D10F0x90: MSI-X Control
744	EHCI[3:1]x02: HC Interface Version	772	D10F0x94: MSI-X Table Offset/Table BIR
744	EHCI[3:1]x04: HC Structural Parameters	772	D10F0x98: MSI-X PBA Offset/PBA BIR
745	EHCI[3:1]x08: HC Capability Parameters	772	D10F0xA0: PCIe Capability List
746	EHCI[3:1]x20: USB Command	773	D10F0xA4: Device Capability
747	EHCI[3:1]x24: USB Status	774	D10F0xA8: Device Control/Status
749	EHCI[3:1]x28: USB Interrupt Enable	775	D10F0xC4: Device Capabilities 2
749	EHCI[3:1]x2C: Frame Index	775	D10F0xC8: Device Control/Status 2
750	EHCI[3:1]x30: Control Data Structure Segment	776	D10F0x100: LTR Extended Capability Header
750	EHCI[3:1]x34: Periodic Frame List Base Address	776	D10F0x104: Max Latency
750	EHCI[3:1]x38: Current Async List Address	776	XHCI_CAPx02: HC Interface Version
750	EHCI[3:1]x60: Configure Flag	777	XHCI_PMx00: xHCI Config 0
751	EHCI[3:1]x[70,6C,68,64]: Port Status Control [4:1]	778	XHCI_PMx04: xHCI Firmware Addr 0
753	EHCI[3:1]xA4: Packet Buffer Threshold Values	778	XHCI_PMx08: xHCI Firmware Addr 1
754	EHCI[3:1]xB4: UTMI Control	778	XHCI_PMx10: xHCI Memory Config
754	EHCI[3:1]xB8: Loopback Test	779	XHCI_PMx14: PLL Control
755	EHCI[3:1]xBC: EOR MISC Control	779	XHCI_PMx20: USB2.0 Wake Control
756	EHCI[3:1]xC0: USB Common PHY CAL and Control	779	XHCI_PMx30: xHCI 1.0 Enable
756	EHCI[3:1]xC4: USB Common PHY Control 1	780	XHCI_PMx48: SSPHY ACPI Indirect Index
757	EHCI[3:1]xD0: USB Common PHY Control 2	780	XHCI_PMx4C: SSPHY ACPI IndirectData
757	EHCI[3:1]xD4: USB Common PHY Control 3	780	XHCI_PMx8C: SSPHY Common Control 0
757	EHCI[3:1]xDC: USB Battery Charger Enable	781	XHCI_PMxA0: SPI BAR0
758	D10F0x00: Device/Vendor ID	781	XHCI_PMxA4: SPI BAR1
758	D10F0x04: Status/Command	781	XHCI_PMxA8: SPI BAR2
759	D10F0x08: Revision ID / Class Code	781	XHCI_PMxAC: SPI BAR3
759	D10F0x0C: Miscellaneous	781	XHCI_PMxB0: SPI Valid Base
759	D10F0x10: Bar 0	782	XHCI_PMxB4: SPI Misc
760	D10F0x14: Bar 1	782	XHCI_PMxB8: FW_DMA_ADDR_LOW
760	D10F0x2C: Subsystem Vendor ID / Subsystem ID	782	XHCI_PMxBC: FW_DMA_ADDR_HIGH
760	D10F0x34: Capability Pointer	782	XHCI_PMx[FC:C0]: SPI Data Block N
760	D10F0x3C: Interrupt Line	783	HCEx40: HCE Control
760	D10F0x40: IDP Index Register	783	HCEx44: HCE Input
761	D10F0x44: IDP Data Register	784	HCEx48: HCE Output
761	D10F0x48: Indirect PCI Index Register	784	HCEx4C: HCE Status
761	D10F0x4C: Indirect PCI Data Register	784	HCEx50: HCE IntrEn
761	D10F0x4C_x08: Port Disable Write Once	786	D14F2x00: Device/Vendor ID
762	D10F0x4C_x0C: Port Disable RW	786	D14F2x04: Status/Command
762	D10F0x4C_x10: USB DCLK Event Counter 0	786	D14F2x08: Class Code/Revision ID
762	D10F0x4C_x14: USB DCLK Event Counter 1	787	D14F2x0C: Header Type
762	D10F0x4C_x18: USB DCLK Event Counter Select	787	D14F2x10: Lower Base Address Register

787	D14F2x14: Upper Base Address Register	815	D14F0x1C: Base Address 3
787	D14F2x2C: Subsystem and Subvendor ID	815	D14F0x20: Base Address 4
787	D14F2x34: Capabilities Pointer	815	D14F0x24: Base Address 5
788	D14F2x3C: Interrupt Line	815	D14F0x28: Cardbus CIS Pointer
788	D14F2x40: Misc Control	815	D14F0x2C: Subsystem Vendor ID
789	D14F2x44: Interrupt Pin/Capability	815	D14F0x30: Expansion ROM Base Address
789	D14F2x50: Power Management Capability	816	D14F0x34: Capability Pointer
789	D14F2x54: Power Management Control and Status	816	D14F0x3C: Interrupt Line
790	D14F2x60: MSI Capability	816	ASFx00: HostStatus
790	D14F2x64: MSI Message Address Low	816	ASFx02: HostControl
791	D14F2x68: MSI Message Address High	817	ASFx03: HostCommand
791	D14F2x6C: MSI Message Data	817	ASFx04: SlaveAddress
791	D14F2x70: Advanced Features Capability	817	ASFx05: Data0
791	D14F2x74: Advanced Features Control and Status	817	ASFx06: Data1
793	D14F7x00: Device/Vendor ID	817	ASFx07: DataIndex
793	D14F7x04: Status/Command	818	ASFx08: PEC
794	D14F7x08: Revision ID/Class Code	818	ASFx09: ListenAdr
794	D14F7x0C: Cache Line Size	818	ASFx0A: ASFStatus
794	D14F7x10: Base Address Reg 0	818	ASFx0B: StatusMask0
794	D14F7x14: Upper Base Address Reg 0	818	ASFx0C: StatusMask1
795	D14F7x2C: Subsystem ID and Subsystem Vendor ID	819	ASFx0D: SlaveStatus
795	D14F7x34: Capabilities Pointer	819	ASFx0E: RemoteCtrlAdr
795	D14F7x3C: Interrupt Line	819	ASFx0F: SensorAdr
795	D14F7x40: Slot Information	819	ASFx10: DataReadPointer
796	D14F7x80: SD PCI MSI Capability Header	819	ASFx11: DataWritePointer
796	D14F7x84: SD PCI MSI Address	819	ASFx12: SetDataReadPointer
796	D14F7x88: SD PCI MSI Upper Address	820	ASFx13: DataBankSel
796	D14F7x8C: SD PCI MSI Data	820	ASFx14: Semaphore
797	D14F7x90: Power Management Capability Header	820	ASFx15: SlaveEn
797	D14F7x94: Power Management Control and Status Register	821	ASFx16: DelayMasterTimer
798	D14F7xB8: SD Auto Pattern	821	SMBUSx00: SMBusStatus
798	SDHC0x00: SDHC System Address / Argument 2	821	SMBUSx01: SMBusSlaveStatus
798	SDHC0x04: SDHC Block CS	822	SMBUSx02: SMBusControl
799	SDHC0x08: SDHC Command Argument	822	SMBUSx03: SMBusHostCmd
799	SDHC0x0C: SDHC Command/Transfer Mode	822	SMBUSx04: SMBusAddress
800	SDHC0x10: SDHC_RESP1_0	823	SMBUSx05: SMBusData0
800	SDHC0x14: SDHC_RESP3_2	823	SMBUSx06: SMBusData1
800	SDHC0x18: SDHC_RESP5_4	823	SMBUSx07: SMBusBlockData
800	SDHC0x1C: SDHC_RESP7_6	823	SMBUSx08: SMBusSlaveControl
800	SDHC0x20: SDHC_BUFFER	824	SMBUSx09: SMBusShadowCmd
801	SDHC0x24: SDHC_PRSENT_STATE	824	SMBUSx0A: SMBusSlaveEvent
801	SDHC0x28: SDHC_CTRL1	824	SMBUSx0C: SlaveData
802	SDHC0x2C: SDHC_CTRL2	824	SMBUSx0E: SMBusTiming
803	SDHC0x30: SDHC_INT_STATUS	824	SMBUSx10: I2CbusConfig
805	SDHC0x34: SDHC_INT_MASK	825	SMBUSx11: I2CCommand
805	SDHC0x38: SDHC_SIG_MASK	825	SMBUSx12: I2CShadow1
806	SDHC0x3C: SDHC ACMD12 Error/Host Control 2	825	SMBUSx13: I2Cshadow2
807	SDHC0x40: SDHC_CAPABILITY	825	SMBUSx14: SMBusAutoPoll
808	SDHC0x44: SDHC_CAPABILITY 2	826	SMBUSx15: SMBusCounter
809	SDHC0x48: SDHC_CURR_CAPABILITY	826	SMBUSx16: SMBusStop
809	SDHC0x50: SDHC_FORCE_EVT	826	SMBUSx17: SMBusHostCmd2
810	SDHC0x54: SDHC_ADMA_ERR	827	IOAPICx00: IO Register Select Register
810	SDHC0x58: SDHC_ADMA_SAD	827	IOAPICx10: IO Window Register
810	SDHC0x6[C:0:step4]: Preset Value	827	IOAPICx10_x00: IOAPIC ID Register
811	SDHC0xE0: Shared Bus Control Register	827	IOAPICx10_x01: IOAPIC Version Register
812	SDHC0xFC: SDHC_VER_SLOT	827	IOAPICx10_x02: IOAPIC Arbitration Register
813	D14F0x00: Device/Vendor ID	828	IOAPICx10_x[3E:10:step2]: Redirection Table Entry [23:0]
813	D14F0x04: Status/Command	828	IOAPICx20: IRQ Pin Assertion Register
814	D14F0x08: Revision ID/Class Code	828	IOAPICx40: EOI Register
814	D14F0x0C: Cache Line Size	829	D14F3x00: Device/Vendor ID
814	D14F0x10: Base Address 0	829	D14F3x04: Status/Command
814	D14F0x14: Base Address 1	830	D14F3x08: Revision ID/Class Code
815	D14F0x18: Base Address 2	830	D14F3x0C: Cache Line Size

830	D14F3x10: Base Address Reg 0	851	HPETx000: ID
830	D14F3x2C: Subsystem ID and Subsystem Vendor ID	851	HPETx004: ClkPeriod
830	D14F3x34: Capabilities Pointer	851	HPETx010: Config
831	D14F3x40: PCI Control	851	HPETx020: Interrupt Status
831	D14F3x44: IO Port Decode Enable	852	HPETx0F0: Main Counter
833	D14F3x48: IO/Mem Port Decode Enable	852	HPETx1[4:0:Step2]0: Timer[2:0] Config Capability
834	D14F3x4C: Memory Range	853	HPETx1[4:0:Step2]8: Timer[2:0] Comparator
834	D14F3x[5C,58,54,50]: ROM Protect 3, 2, 1, 0	853	HPETx1[5:1:step2]0: Timer[2:0] FSB Interrupt Data
834	D14F3x60: PCI Memory Address for LPC Target Cycles	853	HPETx1[5:1:step2]4: Timer[2:0] FSB Interrupt Address
835	D14F3x64: PCI IO base Address for Wide Generic Port	853	HPETx1[D:B]0: Timer[2:0] Comparator Base Shadow
835	D14F3x68: ROM Address Range 1	854	HPETx1[D:B]8: Timer[2:0] Comparator Shadow
835	D14F3x6C: ROM Address Range 2	854	HPETx1E0: Main Counter RTC
836	D14F3x74: Alternative Wide IO Range Enable	854	HPETx1E8: Next Timer Remain
836	D14F3x78: Miscellaneous Control Bits	855	MISCx00: GPPClkCntl
836	D14F3x7C: TPM	857	MISCx04: ClkOutputCntl
837	D14F3x84: TMKBC_BaseAddrLow	859	MISCx08: CGPLLConfig1
838	D14F3x88: TMKBC_BaseAddrHigh	860	MISCx0C: CGPLLConfig2
838	D14F3x8C: TMKBC_Remap	861	MISCx10: CGPLLConfig3
838	D14F3x90: Wide IO 2	862	MISCx14: CGPLLConfig4
838	D14F3x98: EC_LPC_Cntrl	862	MISCx18: CGPLLConfig5
838	D14F3xA0: SPI_Base_Addr	862	MISCx1C: CGPLLConfig6
839	D14F3xA4: EC_PortAddress	863	MISCx20: IMPCalibration
839	D14F3xB0: RomDmaSrcAddr	865	MISCx24: ClkDrvStr1
839	D14F3xB4: RomDmaDstAddr	866	MISCx28: ClkDrvStr2
839	D14F3xB8: RomDmaControl/EcControl/HostControl	867	MISCx2C: ClkGatedCntl
840	D14F3xC0: EcRomWrOffset	868	MISCx30: CGPLLConfig7
841	D14F3xC4: EcRomRdOffset	869	MISCx34: CGPLLConfig8
841	D14F3xC8: ClientRomProtect	869	MISCx38: CGPLLConfig9
841	D14F3xCC: AutoRomCfg	869	MISCx3C: CGPLLConfig10
841	D14F3xD0: ClkCntl	870	MISCx40: MiscClkCntl1
842	D14F3xD4: ClkRunOption	871	MISCx44: MiscClkCntl2
842	SPIx00: SPI_Cntrl0	872	MISCx48: MiscClkCntl3
843	SPIx04: SPI_RestrictedCmd	873	MISCx4C: MiscClkCntl4
844	SPIx08: SPI_RestrictedCmd2	873	MISCx60: IdleCntl
844	SPIx0C: SPI_Cntrl1	873	MISCx68: Memory Power Saving Control
844	SPIx10: SPI_CmdValue0	874	MISCx6C: MiscControl
845	SPIx14: SPI_CmdValue1	874	MISCx70: OscFreqCounter
845	SPIx18: SPI_CmdValue2	874	MISCx74: HpetClkPeriod
846	SPIx1C: Reserved	874	MISCx78: PostCode
846	SPIx1D: Alt_SPI_CS	874	MISCx80: StrapStatus
846	SPIx1E: SpiExtRegIndx	875	MISCx90: AutoTransaction/Allow EC
846	SPIx1F: SpiExtRegData	876	MISCx94: AutoAddrLow
846	SPIx1F_x00: DDR_CMD	876	MISCx98: AutoAddrHigh
847	SPIx1F_x01: QDR_CMD	876	MISCx9C: AutoData
847	SPIx1F_x02: DPR_CMD	876	MISCxC0: CPU Pstate0
847	SPIx1F_x03: QPR_CMD	877	MISCxC4: CPU Pstate1
847	SPIx1F_x04: ModeByte	877	MISCxD0: CPU Cstate0
847	SPIx1F_x05: TxByteCount	877	MISCxD4: CPU Cstate1
847	SPIx1F_x06: RxByteCount	877	MISCxF0: SataPortSts
847	SPIx1F_x07: SPIDataFifoPtr	878	MISCxF4: ClkCntlSts
848	SPIx20: SPI100 Enable	878	GPIOx[0F8:000:step4]: GPIO Bank 0 Control Register
848	SPIx22: SPI100 Speed Config	881	GPIOxFC: GPIO_Wake_Inter_Master Switch
849	SPIx40: DDRCmdCode	882	GPIOx[1FC:100:step4]: GPIO Bank 1 Control Register
849	SPIx41: QDRCmdCode	884	GPIOx[2DC:200:step4]: GPIO Bank 2 Control Register
849	SPIx42: DPRCmdCode	886	GPIOx2F0: GPIO_Wake_Status_Index_0
849	SPIx43: QPRCmdCode	886	GPIOx2F4: GPIO_Wake_Status_Index_1
849	SPIx44: ModeByte	886	GPIOx2F8: GPIO_Interrupt_Status_Index_0
849	SPIx45: CmdCode	887	GPIOx2FC: GPIO_Interrupt_Status_Index_1
849	SPIx47: CmdTrigger	887	IOMUXx00: PWR_BTN_L_AGPIO0
850	SPIx48: TxByteCount	887	IOMUXx01: SYS_RESET_L_AGPIO1
850	SPIx4B: RxByteCount	887	IOMUXx02: WAKE_L_AGPIO2
850	SPIx4C: SpiStatus	888	IOMUXx03: GEVENT2_L_AGPIO3
850	SPIx[C6:80]: FIFO[70:0]	888	IOMUXx04: GEVENT4_L_AGPIO4

888	IOMUXx05: GEVENT7_L_AGPIO5	906	IOMUXx74: CLK_REQ2_L_AGPIO116
889	IOMUXx06: GEVENT10_L_AGPIO6	906	IOMUXx7E: GA20IN_AGPIO126
889	IOMUXx07: GEVENT11_L_AGPIO7	906	IOMUXx81: KBRST_L_AGPIO129
889	IOMUXx08: LPC_SMI_L_AGPIO8	906	IOMUXx82: SATA_ACT_L_AGPIO130
889	IOMUXx09: GEVENT22_L_AGPIO9	907	IOMUXx83: CLK_REQ3_L_AGPIO131
890	IOMUXx0A: GPIO174_AGPIO10	907	IOMUXx84: CLK_REQG_L_AGPIO132
890	IOMUXx0B: BLINK_AGPIO11	908	PMx00: DecodeEn
890	IOMUXx0C: IR_LED_L_LLB_L_AGPIO12	909	PMx04: IsaControl
891	IOMUXx0D: IR_TX0_AGPIO13	910	PMx08: PciControl
891	IOMUXx0E: IR_TX1_AGPIO14	911	PMx0C: StpClkSmaf
891	IOMUXx0F: IR_RX1_AGPIO15	912	PMx44: BootTimerEn
891	IOMUXx10: USB_OC0_L_AGPIO16	912	PMx54: SerialIrqConfig
892	IOMUXx11: USB_OC1_L_AGPIO17	913	PMx56: RTC Control
892	IOMUXx12: USB_OC2_L_AGPIO18	914	PMx58: VRT_T1
892	IOMUXx13: SCL1_EGPIO19	914	PMx59: VRT_T2
892	IOMUXx14: SDA1_EGPIO20	914	PMx5B: RTC Shadow
893	IOMUXx15: LPC_PD_L_AGPIO21	914	PMx5C: LLBCntrl
893	IOMUXx16: LPC_PME_L_AGPIO22	914	PMx5E: RTC ExtIndex
893	IOMUXx17: AC_PRES_IR_RX0_AGPIO23	915	PMx5F: RTC ExtData
894	IOMUXx18: USB_OC3_L/TDO_AGPIO24	915	PMx5F_x00: RTCEXT DltSavEnable
894	IOMUXx19: GEVENT17_L_AGPIO25	915	PMx5F_x01: RTCEXT SprFwdCtrl
894	IOMUXx1A: AZ_SDIN0_EGPIO26	915	PMx5F_x02: RTCEXT SprFwdMonth
894	IOMUXx1B: AZ_SDIN1_EGPIO27	915	PMx5F_x03: RTCEXT FallBackCtrl
895	IOMUXx1C: AZ_SDIN2_EGPIO28	916	PMx5F_x04: RTCEXT FallBackMonth
895	IOMUXx1D: AZ_SDIN3_EGPIO29	916	PMx5F_x10: RTCEXT WeekTimerControl
895	IOMUXx1E: LPCCLK0_EGPIO30	916	PMx5F_x11: RTCEXT WeekTimerReloadLow
896	IOMUXx1F: LPCCLK1_EGPIO31	916	PMx5F_x12: RTCEXT WeekTimerReloadHigh
896	IOMUXx20: SPI_HOLD_L_AGPIO32	917	PMx5F_x13: RTCEXT WeekTimerDataLow
896	IOMUXx21: SPI_CLK_EGPIO33	917	PMx5F_x14: RTCEXT WeekTimerDataHigh
896	IOMUXx22: SPI_CS1_L_AGPIO34	917	PMx60: AcpiPm1EvtBlk
897	IOMUXx23: SPI_CS2_L_AGPIO35	917	PMx62: AcpiPm1CntBlk
897	IOMUXx24: SPI_DI_EGPIO36	917	PMx64: AcpiPmTmrBlk
897	IOMUXx25: SPI_DO_EGPIO37	917	PMx66: CpuCntBlk
898	IOMUXx26: SPI_WP_L_AGPIO38	918	PMx68: AcpiGpe0Blk
898	IOMUXx40: GPIO49_AGPIO64	918	PMx6A: AcpiSmiCmd
898	IOMUXx41: GPIO50_AGPIO65	918	PMx6E: AcpiPm2CntBlk
898	IOMUXx42: GPIO51_AGPIO66	918	PMx74: AcpiConfig
899	IOMUXx43: GPIO55_AGPIO67	919	PMx78: WakeIoAddr
899	IOMUXx44: GPIO57_AGPIO68	919	PMx7A: HaltCountEn
899	IOMUXx45: GPIO58_AGPIO69	919	PMx7C: C1eWrPortAdr
899	IOMUXx46: GPIO59_AGPIO70	919	PMx7E: CStateEn
900	IOMUXx47: GPIO64_AGPIO71	920	PMx80: Break Event
900	IOMUXx48: GPIO68_AGPIO72	921	PMx88: CStateControl
900	IOMUXx49: GPIO69_AGpio73	921	PMx8E: PopUpEndTime
900	IOMUXx4C: GPIO70_AGPIO76	921	PMx94: CStateTiming0
901	IOMUXx4D: GPIO71_AGPIO77	922	PMx98: CStateTiming1
901	IOMUXx54: FANIN0_EGPIO84	922	PMx9C: C2Count
901	IOMUXx55: FANOUT0_EGPIO85	922	PMx9D: C3Count
901	IOMUXx57: SERIRQ_EGPIO87	923	PMxA0: MessageCState
902	IOMUXx58: LPC_CLKRUN_L_AGPIO88	924	PMxB0: DeferTimeTick
902	IOMUXx59: GENINT1_L_AGPIO89	924	PMxB4: Tpreset1b
902	IOMUXx5A: GENINT2_L_AGPIO90	925	PMxB8: Tpreset2
903	IOMUXx5B: SPKR_AGPIO91	925	PMxB9: LpcMisc
903	IOMUXx5C: CLK_REQ0_L_AGPIO92	925	PMxBA: S_StateControl
903	IOMUXx5D: SD_LED_EGPIO93	926	PMxBC: ThrottlingControl
903	IOMUXx5E: SD_CD_EGPIO94	927	PMxBE: ResetControl1
904	IOMUXx5F: SD_CLK_EGPIO95	927	PMxC0: S5/Reset Status
904	IOMUXx60: SD_CMD_EGPIO96	928	PMxC4: ResetCommand
904	IOMUXx[64:61]: SD_DATA[3:0]_EGPIO[100:97]	929	PMxC5: CF9 Shadow
904	IOMUXx65: SD_WP_EGPIO101	929	PMxC8: Misc
905	IOMUXx71: SCL0_EGPIO113	930	PMxCC: IoDrvSth
905	IOMUXx72: SDA0_EGPIO114	930	PMxD0: RstCntrl
905	IOMUXx73: CLK_REQ1_L_AGPIO115	930	PMxD1: Reset Function

931	PMxD1_x0: RstLength	945	AcpiPmEvtBlkx00: Pm1Status
931	PMxD1_x1: APURstLength	946	AcpiPmEvtBlkx02: Pm1Enable
931	PMxD1_x3: APUPwrGdLength	947	AcpiPm1CntBlkx00: PmControl
931	PMxD2: Pmio	947	AcpiPm2CntBlkx00: Pm2Control
931	PMxD3: ManualReset	947	AcpiPmTmrBlkx00: TmrValue/ETmrValue
932	PMxD6: IMC Gating	947	CpuCntBlkx00: ClkValue
932	PMxD8: Eprom Index	948	CpuCntBlkx04: PLv12
932	PMxD9: Eprom Data	948	CpuCntBlkx05: PLv13
932	PMxDA: SataConfig	948	AcpiGpe0Blkx00: EventStatus
933	PMxDC: SataConfig2	948	AcpiGpe0Blkx04: EventEnable
933	PMxE0: ABRRegBar	949	SmiCmdBlkx00: SmiCmdPort
933	PMxE4: AB Misc Control	949	SmiCmdBlkx01: SmiCmdStatus
933	PMxE8: SDFlashCntrl	950	SMIx00: Event_Status
933	PMxEB: AzEn	950	SMIx04: Event_Enable
934	PMxEC: LpcGating	950	SMIx08: SciTrig
934	PMxED: USB Gating	952	SMIx0C: SciLevl
934	PMxEF: USB Enable	953	SMIx10: SmiSciStatus
935	PMxF0: USB Control	953	SMIx14: SmiSciEn
936	PM2x00: Fan0InputControl	953	SMIx18: SwSciEn
936	PM2x01: Fan0Control	953	SMIx1C: SwSciData
937	PM2x02: Fan0Freq	953	SMIx20: SciSleepDisable
937	PM2x03: LowDuty0	954	SMIx30: CapturedData
937	PM2x04: MedDuty0	954	SMIx34: CapturedValid
937	PM2x05: Multiplier0	954	SMIx38: EPBIF_AER_Straps
938	PM2x06: LowTemp0Lo	955	SMIx3C: DataErrorStatus
938	PM2x07: LowTemp0Hi	955	SMIx40: SciMap0
938	PM2x08: MedTemp0Lo	956	SMIx44: SciMap1
938	PM2x09: MedTemp0Hi	956	SMIx48: SciMap2
938	PM2x0A: HighTemp0Lo	957	SMIx4C: SciMap3
939	PM2x0B: HighTemp0Hi	957	SMIx50: SciMap4
939	PM2x0C: LinearRange0	958	SMIx54: SciMap5
939	PM2x0D: LinearHoldCount0	958	SMIx58: SciMap6
939	PM2x0E: Fan0Hysteresis	959	SMIx5C: SciMap7
939	PM2x50: Med2Temp0Lo	959	SMIx60: SciMap8
939	PM2x51: Med2Temp0Hi	959	SMIx64: SciMap9
939	PM2x52: Med2Duty0	959	SMIx68: SciMap10
940	PM2x53: Multiplier2_0	960	SMIx6C: SciMap11
940	PM2x60: FanStatus	960	SMIx70: SciMap12
940	PM2x61: FanINTRouteLo	961	SMIx74: SciMap13
940	PM2x63: SampleFreqDiv	961	SMIx78: SciMap14
941	PM2x64: FanDebounceCounterLo	962	SMIx7C: SciMap15
941	PM2x65: FanDebounceCounterHi	962	SMIx80: SmiStatus0
941	PM2x66: Fan0DetectorControl	963	SMIx84: SmiStatus1
941	PM2x67: Fan0SpeedLimitLo	964	SMIx88: SmiStatus2
942	PM2x68: Fan0SpeedLimitHi	965	SMIx8C: SmiStatus3
942	PM2x69: Fan0SpeedLo	965	SMIx90: SmiStatus4
942	PM2x6A: Fan0SpeedHi	966	SMIx94: SmiPointer
942	PM2x8A: TempTsiLo	966	SMIx96: SmiTimer
942	PM2x8B: TempTsiHi	966	SMIx98: SmiTrig0
942	PM2x8C: TempTsiLimitLo	967	SMIx9C: SmiTrig1
942	PM2x8D: TempTsiLimitHi	968	SMIxA0: SmiControl0
942	PM2x8E: TempTsiChangeLimit	968	SMIxA4: SmiControl1
943	PM2x8F: TempTsiWe	969	SMIxA8: SmiControl2
943	PM2x90: TempTsiStatus	969	SMIxAC: SmiControl3
943	PM2x92: TempTsiControl	970	SMIxB0: SmiControl4
944	PM2x94: TempTsiINTRoute	971	SMIxB4: SmiControl5
944	PM2xDF: TempTsiRstSel	971	SMIxB8: SmiControl6
944	PM2xE0: AlertThermaltripStatus	972	SMIxBC: SmiControl7
944	PM2xE1: AlertLimitLo	972	SMIxCO: SmiControl8
944	PM2xE2: AlertLimitHi	972	SMIxC4: SmiControl9
945	PM2xE3: ThermalTripLimitLo	973	SMIx8C: IoTrapping0
945	PM2xE4: ThermalTripLimitHi	973	SMIxCA: IoTrapping1
945	PM2xE5: AlertThermaltripControl	973	SMIxCC: IoTrapping2

973 SMIxCE: IoTrapping3
973 SMIxD0: MemTrapping0
974 SMIxD4: MemRdOvrData0
974 SMIxD8: MemTrapping1
974 SMIxDC: MemRdOvrData1
974 SMIxE0: MemTrapping2
974 SMIxE4: MemRdOvrData2
975 SMIxE8: MemTrapping3
975 SMIxEC: MemRdOvrData3
975 SMIxF0: CfgTrapping0
975 SMIxF4: CfgTrapping1
975 SMIxF8: CfgTrapping2
976 SMIxFC: CfgTrapping3
977 WDTx00: WatchdogControl
977 WDTx04: WatchdogCount
978 AcDcTimerx00: AcTimerValue
978 AcDcTimerx04: AcExpiredTimerPolicy
978 AcDcTimerx08: AcTimerStatus
979 AcDcTimerx10: DcTimerValue
979 AcDcTimerx14: DcExpiredTimerPolicy
979 AcDcTimerx18: DcTimerStatus
979 AcDcTimerx20: AcDcTimerCtrl